BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen
(D) [ ] No distribution

Datasheet for the decision of 16 September 2011

Case Number: T 0618/06 - 3.3.05

Application Number: 95934413.6

Publication Number: 0796137

IPC: B01D 53/94

Language of the proceedings: EN

Title of invention:
Close coupled catalyst and method of operating the same

Patentee:
ENGELHARD CORPORATION

Opponent:
Umicore AG & Co. KG

Headword:
Close coupled catalyst/ENGELHARD CO

Relevant legal provisions:
EPC Art. 54, 56, 83, 123(2)

Keyword:
"Allowability of the amendments: Main request and first auxiliary request (no)"
"Sufficiency of disclosure: second and third auxiliary request (yes)"
"Novelty: second and third auxiliary request (yes)"
"Inventive step: second and third auxiliary request (no) - obvious alternative"

Decisions cited:
-

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0618/06 **-** 3.3.05

D E C I S I O N
of the Technical Board of Appeal 3.3.05
of 16 September 2011

Appellant: (Opponent)
Umicore AG & Co. KG
Rodenbacher Chaussee 4
D-63457 Hanau-Wolfgang (DE)

Representative:
Berryman, Natalia Grace
Vossius & Partner
Postfach 86 07 67
D-81634 München (DE)

Respondent: (Patent Proprietor)
ENGELHARD CORPORATION
101 Wood Avenue
Iselin
New Jersey 08830-0770 (US)

Representative:
Fisher, Adrian John
Carpmaels & Ransford
One Southampton Row
London WC1B 5HA (GB)

Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 6 February 2006 concerning maintenance of the European patent No. 0796137 in amended form.**

Composition of the Board:

Chairman: G. Raths
Members: E. Waeckerlin
C. Vallet

Summary of Facts and Submissions

I. The present appeal is from the interlocutory decision of the opposition division dated 6 February 2006 concerning maintenance of European patent No. EP 0 796 137 B1 in amended form based on claims 1 to 24 of the first auxiliary request submitted by the proprietor of the patent at the oral proceedings on 30 November 2005 before the opposition division.

European patent No. EP 0 796 137 B1 is based on application No. 95 934 413.6, corresponding to PCT application WO 96/017671 with the international filing date of 12 September 1995 and the priority date of 6 December 1994.

II. In the decision under appeal, the opposition division arrived at the conclusion, that claim 17 of the main request then on file was not in conformity with Article 123(2) EPC, because the upper limit for the amount of palladium had been omitted from said claim. Moreover, it was found, that claim 28 of the main request was not in conformity with Article 123(3) EPC, because the words *"after warm up"* had been omitted from said claim.

Regarding the first auxiliary request then on file, the opposition division held, that the article according to claim 1 was distinguished from the closest prior art E1 in that the closed coupled catalyst (*"CCC"*) comprised an amount of at least 50 g/ft^3 and up to 500 g/ft^3 of palladium, and in that the support of the *"CCC"* comprised activated alumina.

In the absence of a proof of a *"synergetic effect"* produced by the two distinguishing features, the technical problem underlying the claimed invention was to provide an alternative article.

Starting from document E1 and taking the disclosure of document E12 into consideration, the skilled person would have increased the amount of palladium in the *"CCC"* to the claimed level. In contrast, the skilled person would not have considered to use activated alumina as (part of) the support of the *"CCC"*.

Therefore, the opposition division concluded, that the subject-matter of claim 1 of the first auxiliary request involved an inventive step.

III. Notice of appeal was filed by the appellant (opponent) on 18 April 2006, requesting the revocation of the patent on grounds of insufficient disclosure of the invention and lack of inventive step.

IV. The parties to the appeal procedure relied *inter alia* on the following documents:

E1: JP 62 136245 A (together with abstract and translation into German);
E1e: English translation of E1;

E3: JP 4 287 820 A (together with abstract and translations into German and English);

E4: US 4 624 940 A;

E5: EP 0 190 883 A2;

E7: US 3 896 616 A;

E9: DE 195 22 913 A1;

E10: GB 2 290 488 A;

E11: DE 44 06 648 C1;

E12: Summers, J. C. et al.: *"Use of Light-Off Catalysts to Meet the California LEV/ULEV Standards."* SAE Technical Paper Series 930386, 1993, p. 143 - 158.

E13: Ball, D. J.: *"A Warm-up and Underfloor Converter Parametric Study."* SAE Technical Paper Series 932765, 1993, p. 179 - 189.

The appellant raised various objections under Article 100(b) EPC, referring in particular to the following features of claim 1 then on file:
(i) the position of the close coupled catalyst;
(ii) the feature of *"substantially no oxygen storage components selected from the group consisting of cerium compounds and praesodymium components"*; and
(iii) the composition of the close coupled catalyst and the downstream catalyst.

Regarding inventive step, the appellant submitted, that the use of an amount of palladium of 1.77 kg/m^3 (50 g/ft^3) to 17.7 kg/m^3 (500 g/ft^3) was obvious from the disclosure of E12. The use of activated alumina was obvious on its part from the disclosure of E1. This was especially true, since activated alumina was the standard support in close coupled catalysts. In this

respect, the appellant referred to documents E3, E7 and E11. The appellant concluded, that the subject-matter of claim 1 was obvious having regard to E1 alone, or E1 in combination with either E3 or E7. As far as the absence of cerium compounds was concerned, both documents E4 and E5 disclosed this feature, and additional evidence was provided by documents E9, E10 and E11. In any case, the absence of cerium and praesodymium was not a determinant factor regarding the thermal stability of the close coupled catalysts. Rather, said stability resulted from replacing cerium and praesodymium by more effective stabilisers such as lanthanum oxide or neodymium oxide. Since claim 1 did not reflect this, the alleged advantage of a high stability was not achieved over the whole scope of the claim.

V. In reply, the respondent submitted seven sets of claims with letter dated 2 November 2006, representing the main request and auxiliary requests 1 to 6. In addition, the following documents were submitted *inter alia*:

A1: *"Declaration of Dr. Harold N. Rabinowitz"* dated 1 November 2006, 14 p., together with attachments 1 to 5;
Attachment 1: List of publications of Dr. H. Rabinowitz;
Attachment 2: Claim 1 of EP 0 796 137;
Attachment 3: (A1b) Sharp, D. (ed.): The Penguin Dictionary of Chemistry. Second edition, London: Penguin Books, 1990, p. 87, 234, 270, 326;
Attachment 4: (A1c) *"Experimental details regarding the stability and efficacy of activated*

alumina", received by the EPO on 2 November 2006, 4 p.;
Attachment 5: (A1d) *"Chart showing total FTP 1975 NMHC v. Pd loading on the close coupled catalyst"*, 1 p.

The respondent refuted the appellant's objections with letter dated 16 August 2011 and submitted a corrected version of auxiliary request 1.

In two further letters dated 16 August 2011 and 13 September 2011, the appellant expanded its argumentation, referring *inter alia* to three further documents.

The appellant raised objections under Article 123(2) EPC against claims 1 and 21 of the main request then on file. The previous objections on grounds of insufficient disclosure and lack of inventive step were maintained.

VI. Oral proceedings were held on 16 September 2011. In the course of oral proceedings, the respondent submitted four sets of claims representing the main request and auxiliary requests 1 to 3.

Claim 1 of the main request has the following wording:

"1. An article comprising:

a gasoline engine (12) having an exhaust outlet (14) and optionally an exhaust manifold outlet (19);

a close coupled catalyst (20) located less than 30.48 cm (one foot) from the engine exhaust outlet or exhaust manifold outlet and in communication with the exhaust outlet, the close coupled catalyst comprising a close coupled catalyst composition having substantially no oxygen storage components selected from the group consisting of cerium components and praseodymium components, the catalyst composition comprising:

a support comprising activated alumina; and

a palladium component at an amount such that the close coupled catalyst contains at least 1.77 kg/m^3 (50 g/ft^3) and up to 17.7 kg/m^3 (500 g/ft^3) of palladium;

and a downstream catalyst (24) located downstream of and in communication with the close-coupled catalyst, the downstream catalyst comprising an oxygen storage component selected from the group consisting of cerium components and praseodymium components."

Claim 1 of auxiliary request 1 corresponds to claim 1 of the main request, but with the additional feature, according to which the catalyst composition comprises

"an alkaline earth metal compound derived from a metal selected from the group consisting of magnesium, barium, calcium, strontium and mixtures thereof."

Claim 1 of auxiliary request 2 corresponds to claim 1 of auxiliary request 1, but with the following further specification of features:

"the close coupled catalyst comprising a close coupled catalyst carrier which supports the close coupled catalyst composition, the carrier comprising a honeycomb carrier and the close coupled catalyst composition comprising: from 0.03 to 0.21 g/cm^3 (0.50 to 3.5 g/in^3) of activated alumina support; a palladium component such that the close coupled catalyst contains from 1.77 to 14.16 kg/m^3 (50.0 to 400 g/ft^3) of palladium; and from 0.003 to 0.03 g/cm^3 (0.05 to 0.5 g/in^3) of at least one alkaline earth metal component."

Claim 1 of auxiliary request 3 corresponds to claim 1 of auxiliary request 2, but with the following additional features (i), (ii), (iii) and (iv) (these reference numbers being used for purpose of facilitating the enumeration):

(i) the alkaline earth metal component *"including from 0.003 to 0.024 g/cm^3 (0.05 g/in^3 to 0.4 g/in^3) of strontium oxide;"*

(ii) the close coupled catalyst composition further comprising *"from 0.0 to 0.03 g/cm^3 (0.0 to 0.5 g/in^3) of zirconium oxide;"* and

(iii) *"from 0.0 to 0.03 g/cm^3 (0.0 to 0.5 g/in^3) of at least one rare earth metal oxide selected from the group consisting of lanthanum oxide and neodymium oxide;"*

(iv) the downstream catalyst being *"a three way downstream catalyst"*.

VII. As far as the arguments of the appellant still apply to the requests now on file, they can be summarised as follows:

In the application as originally filed, there is no support for the combination of features contained in claim 1 of the main request and the first auxiliary request, according to which the close coupled catalyst composition comprises activated alumina, and a palladium component at an amount, that the close coupled catalyst contains at least 1.77 kg/m^3 and up to 17.7 kg/m^3 of palladium. Nowhere in the application as originally filed, there is a disclosure of the claimed range of the amount of palladium in combination with alumina as the support, and more specifically with activated alumina. Claim 7, which is directed to the preferred use of activated alumina as support, is restricted to layered catalysts and does not mention the amount of palladium. Therefore, an objection under Article 123(2) EPC arises.

Regarding the requirement of sufficiency of disclosure, the patent in suit does not define, how the distance between the engine exhaust outlet or exhaust manifold outlet is to be determined.

Moreover, claim 1 of the main request recites that substantially no oxygen storage components selected from the group consisting of cerium components and praesodymium components are contained in the close coupled catalyst composition. Neither the wording of the claim, nor the patent in suit as a whole provides an unambiguous delimitation of the amounts of cerium components and praesodymium components, which may be

present, for example as an admixture of lanthanum, which is a potential component of the catalyst composition. According to the description of the patent in suit, *"minor amounts"* of ceria and praesodymium may be present as impurities or trace amounts. But neither the term *"impurity"* nor *"trace amount"* is defined. In spite of the wording of the claims, the presence of oxygen storage components is not completely excluded, because only ceria and praesodymia are restricted in the claims, whereas other oxygen storage components, for example iron nickel, cobalt, lanthanum and neodymium may be present in unlimited amounts. Such compounds are even preferred as components of the close coupled catalyst composition. There is no disclosure in the patent in suit, how the amount of carbon monoxide oxidation in the close coupled catalyst can be limited.

For these reasons, the patent in suit does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

Regarding inventive step, the appellant argued *in essence*, that E1 disclosed the use of activated alumina as support of the close coupled catalyst composition, since the support which was formed in the practical example of the *"first invention"* of E1 contained activated alumina. Thus, the use of activated alumina could not be regarded as a distinguishing feature. In reality, there was only one distinguishing feature, namely the range of the amount of palladium contained in the close coupled catalyst. In any case, there existed no interrelationship between the two features, let alone a synergistic effect.

Referring specifically to documents E3, E4, E5, E7, E11 and E12, the appellant concluded that the claimed subject-matter did not involve an inventive step, especially having regard to the disclosure of E1 in combination with either E12 or E4.

VIII. The arguments of the respondent can be summarised as follows:

The patent in suit disclosed the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

Moreover, novelty of the claimed subject-matter was not at stake.

The technical problem underlying the invention consisted in reducing the amount of hydrocarbons emitted during the cold start period, whilst addressing both the control over other pollutants present in the exhaust gas and the durability of the catalyst system.

The solution provided by the invention required, in the close coupled catalyst, the combination of activated alumina with a specific minimum loading of palladium and, simultaneously, the exclusion of oxygen cerium components and praseodymium components. In addition, it required, in the downstream catalyst located downstream of the close coupled catalyst, the presence of cerium components or praseodymium components as oxygen storage components.

Regarding the experimental evidence in support of the benefits of the invention, the respondent referred to examples 1 to 4 of the description of the patent in suit, and to the declaration A1 together with attachments A1c and A1d. The respondent argued, that the catalyst system according to the invention had a particularly low light-off temperature for each of CO, HC and NO_x; also, close coupled catalysts according to the invention oxidised less carbon monoxide than comparable catalysts that included cerium components. The experiments showed, that the minimum level of palladium loading on the close coupled catalyst was critical in achieving the required target level for hydrocarbon emissions. Catalysts containing aged activated alumina retained their activity in the absence of any stabilising component, unlike catalysts containing aged α-alumina.

The respondent argued further, that nothing in E1 motivated the skilled person to propose the claimed subject-matter and the technical benefits that it provides. There was no reason, why the teaching of E1, taken together with any other document referred to by the appellant, in particular E1 in combination with E12, would have prompted the skilled person to arrive at the invention.

IX. Requests

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

The respondent requested that the patent be maintained according to the main request or, alternatively,

according to one of the auxiliary requests 1 to 3, all requests filed at the oral proceedings.

X. At the end of the oral proceedings held on 16 September 2011 the board announced its decision to revoke the patent in suit.

Reasons for the Decision

1. Sufficiency of the disclosure - Article 100(b) EPC

1.1 The appellant raised various objections on grounds of insufficient disclosure, alleging in particular:

(i) that the patent in suit did not give a method for determining the distance between the close coupled catalyst and the engine exhaust outlet or exhaust manifold outlet;

(ii) that the feature in claim 1, according to which the close coupled catalyst composition had *"substantially no oxygen storage components selected from the group of cerium components and praesodymium components"*, did not rule out *"minor amounts"* of these components. In this context, the appellant referred to document E4, where amounts of *"about 15 % ceria"* and *"about 10 % praesodymia"* were described as *"minor amounts"*;

(iii) that the wording of claim 1 allowed the presence of any amounts of oxygen storage components other than cerium components and praesodymium components, e.g.

nickel, cobalt and rare earths other than Ce and Pr, thus compromising the effect of avoiding Ce and Pr;

(iv) that the specific compositions of the close coupled catalyst and the *"downstream catalyst"* were not disclosed in detail in the patent in suit.

Under these circumstances, so the appellant argued, it was uncertain, whether a controlled bypass of carbon monoxide could be achieved in the close coupled catalyst. In any case, the skilled person could not put the invention into practice without undue experimentation.

1.2 The board is not convinced by these arguments for the following reasons:

(i) According to claim 1, the close coupled catalyst is located less than 30.48 cm from the engine exhaust outlet or exhaust manifold outlet. The inlet of the close couplet catalyst may be attached directly to said outlet of the engine, or it may be arranged in close proximity of less than 30.48 cm (1 foot), preferably less than 15.24 cm (see claim 1 and patent, page 5, lines 12 - 16; page 7, lines 8 - 11; Fig. 1, reference signs 19, 20, 22). In the opinion of the board, the skilled person can easily find an arrangement having a proper distance between the engine and the close coupled catalyst. Likewise, it is easy to verify, whether the distance is less than 30.48 cm as required by claim 1, since standard methods of length measurement can be applied. In this respect, the skilled person does not need any special guidance from the patent in suit.

(ii) The wording of claim 1 implies, that as a matter of principle, the close coupled catalyst composition does not contain any cerium components and praesodymium components. Nevertheless, minor amounts of ceria or praesodymia may be present as impurities or trace amounts (see patent, page 5, lines 46). The question arises, whether the patent provides sufficient guidance to the skilled person and what is meant by the expression *"minor amounts"*. At the oral proceedings, the respondent explained, that cerium components and praesodymium components were contaminants and as such undesirable. They should be avoided as far as possible. It may nevertheless happen that, inadvertently, impurities or trace amounts of ceria or praesodymium were present, for example in the form of admixtures of lanthanum. The wording of claim 1 took this into account.

The board notes, that the explanation given by the respondent is in conformity with the description of the patent in suit. Both examples 1 and 3 of the patent concern close coupled catalyst compositions containing no cerium or praesodymium components at all (see patent, page 11, lines 5 - 7; 51 - 52, examples 1, 3). Moreover, it is plain from the description, that the main purpose of the absence of cerium components and praesodymium components from the close coupled catalyst composition consists in limiting the amount of oxidation of carbon monoxide in the close coupled catalyst, even when the engine exhaust gases are hot (see patent, page 5, lines 53 - 55). Therefore, the skilled person recognises immediately, that if at all, only low levels of cerium components or praesodymium

components can be accepted (see patent, page 5, line 46). Otherwise, the desired limitation of the carbon monoxide oxidation would not be achieved.

In the opinion of the board, there exists no lack of disclosure in this respect. It is immaterial, that in document E4, the expression *"minor amounts"* is given a broader meaning in order to encompass amounts of ceria and praesodymia of up to 10 %, 15 % or even more (see E4, col. 2, lines 24 - 30). E4 is not concerned with the problem of limiting the amount of oxidation of carbon monoxide, but addresses on the contrary the promotion of carbon monoxide oxydation. Accordingly, praesodymia is not excluded from the catalyst compositions described in E4, whereas ceria and zirconia are explicitly mentioned as suitable components for the stabilisation of γ-alumina particles (see E4, claim 1; col. 2, lines 40 - 46).

The board concludes, therefore, that the patent in suit provides the unambiguous teaching to the skilled person, that cerium components and praesodymium components are unwanted in the close coupled catalyst composition and should be avoided as far as possible. There exists no difficulty of putting this teaching into practice.

(iii) As far as the presence of other oxygen storage components than ceria and praesodymia is concerned, the description of the patent in suit states, that the close coupled catalyst composition can optionally comprise lanthanum oxide or neodymium oxide. These components are preferred (see patent, claim 2; page 7, lines 44 - 48). Further components may also be present,

including platinum, rhodium, ruthenium, iridium, zirconium, nickel and iron (see patent, page 6, lines 23 - 29; page 7, lines 48 - 51; page 8, lines 9 - 10; page 9, lines 20 - 22, 27; page 9, line 57 to page 10, line 2; page 11, lines 6 - 7). Certain of these components are well known to possess significant oxygen storage capabilities, in particular iron, nickel, lanthanum and neodymium (see patent, page 3, lines 36 - 38, referring to US 4 923 842). Thus, the patent in suit discloses directly and unambiguously, that while cerium components and praesodymium components are excluded, other oxygen storage components may, in fact, be present.

Nevertheless, this does not affect the skilled person's ability to put the claimed invention into practice. The skilled person may, for example, reproduce the examples 1 or 3 of the patent in suit without any difficulty.

(iv) Regarding the composition of the close coupled catalyst and the downstream catalyst, the board notes, that the patent in suit contains detailed information about the components of close coupled catalysts according to claim 1. The close coupled catalyst composition may comprise components of the type used in conventional three-way catalyst compositions, except that cerium components and praesodymium components are absent (see page 5, lines 38 - 39; page 6, lines 15 - 29; page 7, lines 41 - 49; page 8, lines 2 - 11, 38 - 43; pages 10 to 11, examples 1 and 3).
The components of the downstream catalyst composition are also described in detail in the patent in suit. Preferably, three-way catalysts known in the state of the art are used, comprising a cerium component or a

praesodymium component (see patent, page 6, line 14; page 8, lines 12 - 23, 44 - 49; page 9, line 32 to page 10, line 2).

The board is satisfied, that the disclosure regarding the composition of both the close coupled catalyst and the downstream catalyst is sufficient for the skilled person to put the subject-matter of claim 1 into practice.

1.3 For the reasons set out above, the board concludes, that the patent in suit meets the requirements laid down in Article 83 EPC. Therefore, the objections under Article 100(b) EPC raised by the appellant are mistaken.

2. Main request: Allowability of the amendments - Article 123(2) EPC

2.1 Claim 1 of the main request is based on claim 19 of the application as originally filed, i.e. as published by WIPO under the Patent Cooperation Treaty (PCT), in combination with the following parts of the description:

(i) page 15, lines 19 - 20; page 15, line 34 to page 16, line 3: close coupled catalyst in close proximity to the exhaust outlet or exhaust manifold outlet;

(ii) page 10, lines 6 - 9; page 12, lines 31 - 36: proximity of the close coupled catalyst to the engine typically less than one foot, corresponding to 30.48 cm in SI units;

(iii) page 20, lines 26 - 29: amount of palladium component sufficient to attain up to 500 g/ft^3, preferably 50 - 400 g/ft^3, thus disclosing the range of 50 g/ft^3 - 500 g/ft^3, corresponding to 1.77 kg/m^3 - 17.7 kg/m^3 in SI units.

2.2 The question arises, whether the application as originally filed contains a basis for the feature of claim 1, according to which the support of the catalyst composition of the close coupled catalyst comprises *"activated alumina"*. In the description, it is specified, that the terms *"activated alumina"* and *"γ-alumina"* refer to high surface area support materials, usually mixtures of the gamma and delta phases of alumina, but optionally mixtures containing also substantial amounts of eta, kappa and theta alumina phases (see application as originally filed, page 4, lines 11 - 17).

2.3 At the oral proceedings, the respondent submitted that claim 7 of the application as originally filed, as well as example 1 and the section of the description dealing with stabilisers formed a proper basis for the feature of *"a support comprising activated alumina"* in claim 1 of the patent in suit (see application as originally filed, claim 7; page 27, lines 11 - 14; page 21, lines 12 - 17, referring to US 4 727 052 A). Having regard to said disclosure, the skilled person would have recognised at the date of filing, that activated alumina was foreseen as support material. This view was contested by the appellant, who argued, that the use of activated alumina was disclosed in the application as originally filed only in the specific context of

example 1. Therefore, the incorporation of the feature in claim 1 amounted to an unallowable generalisation.

2.4 The board notes, that claim 7 of the application as originally filed does not relate to close coupled catalysts in general, but specifically to layered catalysts. The same applies to example 1, which concerns a two layered catalyst comprising a monolith support made of cordierite coated with a washcoat composition containing γ-alumina (see application as originally filed, page 27, lines 11 - 32; page 28, lines 9 - 12). Nor does the passage on page 21 of the description relied upon by the respondent disclose in a general manner, that the support of the catalyst composition of the close coupled catalyst comprises activated alumina. Rather, it is stated there, that activated alumina can be thermally stabilised by using stabilisers to retard undesirable alumina phase transformations from gamma to alpha at elevated temperatures. The question, whether activated alumina can be used in all embodiments encompassed by claim 1, is not addressed.

As far as the other passages of the description are concerned, where activated alumina is mentioned, they all refer to specific embodiments and not to the close coupled catalysts in general (see application as originally filed, page 14, lines 5 - 11; page 18, lines 7 - 10; page 21, line 35 - page 22, line 4).

2.5 For these reasons, the board arrives at the conclusion, that the inclusion in claim 1 of the feature of a support comprising activated alumina is not in

conformity with Article 123(2) EPC. Therefore, the main request is not allowable.

3. First auxiliary request: Allowability of the amendments - Article 123(2) EPC

3.1 Claim 1 of auxiliary request 1 follows the wording of claim 1 of the main request, with the additional feature, according to which the catalyst composition comprises an alkaline earth metal compound derived from magnesium, barium, calcium or strontium. The basis for the additional feature is page 19, lines 21 - 25 of the application as originally filed.

Nevertheless, claim 1 of the first auxiliary request is not in conformity with Article 123(2) EPC, because it contains the feature of *"a support comprising activated alumina"* as in the case of claim 1 of the main request. Therefore, the first auxiliary request is not allowable.

4. Second and third auxiliary requests: Allowability of the amendments - Article 123(2) EPC

4.1 Claim 1 of the second auxiliary request has the same basis in the application as originally filed as claim 1 of the main request (see above). In addition, it is based on claims 8, 10, 11, and page 18, lines 26 - 27 of the application as originally filed.

4.2 Claim 1 of the third auxiliary request has the same basis in the application as originally filed as claim 1 of auxiliary request 2. In addition, it is based on claim 10, as well as page 18, line 37 to page 19,

line 3 and page 19, lines 4 - 5 of the application as originally filed.

4.3 No objection was raised by the appellant in this respect, and the board is satisfied, that claim 1 and dependent claims 2 to 19, of the second auxiliary request, as well as claim 1 and dependent claims 2 to 15 of the third auxiliary request are in conformity with Article 123(2) EPC.

5. Second and third auxiliary requests: Novelty - Article 54 EPC

5.1 No objection on grounds of lack of novelty was raised by the appellant during the appeal proceedings. In this case, having regard to particular technical aspects, the board finds it appropriate to comment on document E1e.

5.2 Document E1e discloses an article comprising a gasoline engine (1) having an exhaust outlet manifold (2); a close coupled catalyst (*"first catalyst"*, see E1e, Figure, reference sign 4) located directly below the engine exhaust manifold outlet and in communication with the exhaust outlet (see E1e, page 8, lines 21 - 22; Figure, reference signs 2, 4), the close coupled catalyst comprising a close coupled catalyst composition having no *"oxygen storage components selected from the group consisting of cerium components and praesodymium components"*, the close coupled catalyst comprising a close coupled catalyst carrier which supports the close coupled catalyst composition, the carrier comprising a honeycomb carrier (see E1e, page 9, lines 24 - 25; page 10, lines 15 - 16,

"cordierite monolithic carrier substrate with 400 cells/square inch 107 mm in diameter and 78 mm long") and the close coupled catalyst composition comprising:

(i) an activated alumina support;

(ii) a palladium component in the form of palladium chloride $PdCl_2$ in such an amount that the close coupled catalyst contained 1 kg/m^3 of palladium (*"Pd = 1 g/L"*, see E1e, page 7, lines 24 - 26); and

(iii) a downstream catalyst located downstream of and in communication with the close coupled catalyst (*"second catalyst"*, see E1e, Figure, reference signs 5, 7), the downstream catalyst comprising an oxygen storage component in the form of a cerium component (see E1e, page 7, lines 16 - 20; page 7, line 27 to page 8, line 2).

In addition, E1e discloses that the use of rare earth metals and alkali metals carried together with conventional catalytic metals such as palladium, rhodium or platinum is effective in terms of thermostability, when activated alumina is used as the carrier layer (see page 5, lines 9 - 12; page 4, line 26 to page 5, line 7).

5.3 At the oral proceedings, controversial views were expressed by the parties regarding the question, whether E1e disclosed, that the alumina used as support material for the close coupled catalyst, i.e the *"first catalyst"* of E1e, was *"activated alumina"*.

The appellant referred to the statement in E1e, according to which alkali metals carried together with lanthanum and cerium are *"effective in terms of thermostability when activated alumina is used as the carrier layer"* (see E1e, page 5, lines 9 - 11). In any case, activated alumina was disclosed inherently by the conditions used in the *"practical example"* of E1e (see E1e, page 7, lines 11 - 23). In the appellant's view, at least the alumina sol used in the *"practical example"* contained γ-alumina.

The respondent argued, that E1e did not disclose the type of alumina used. In the *"practical example"* α-alumina could have been used. As far as E1e mentioned activated alumina, it referred to catalysts containing cerium as a stabiliser.

5.4 The board notes, that activated alumina is expressly mentioned in E1e as a suitable material for the catalyst carrier layer of the catalysts (see E1e, page 5, lines 9 - 11). Furthermore γ-alumina is disclosed among the preferred material for the first catalyst (see E1e, page 5, line 27 to page 6, line 2). Nowhere in E1e, it is stated, that activated alumina has to be used in combination with cerium. Apart from this, the description of the practical examples contains details about the method for producing the alumina support for the close coupled catalyst. The support was obtained by impregnating alumina powder with $Nd(NO_3)_3$, firing the product for 2 hours at 700 °C, mixing it with $Al(NO_3)_3$, alumina sol and water, thus obtaining a slurry *"S_1"*. Subsequently, the cordierite monolithic carrier is impregnated with the slurry *"S_1"*,

dried for 1 hour at 200 °C and fired for 2 hours at 600 °C (see E1e, page 7, lines 11 - 15; 21 - 24).

Having regard to the conditions used in the preparation of the alumina support, in particular the two firing operations at 700 °C and 600 °C, respectively, it is beyond any reasonable doubt, that the obtained product comprised activated alumina. It is well known in the state of the art, that activated alumina can be prepared by precipitating hydrous alumina gel and thereafter drying and calcining the product at temperatures from 300 °C to 800 °C to expel hydrated water and provide active alumina (see, for example, E7, col. 11, lines 22 - 29).

The board concludes, therefore, that the feature of a close coupled catalyst comprising an activated alumina support forms part of the disclosure of E1e.

5.5 The article according to claim 1 of the **second auxiliary request** is distinguished from the article disclosed in E1e by the indication of the range of 0.03 to 0.21 g/cm^3 for the amount of the activated alumina support, by the indication the range of 1.77 to 14.16 kg/m^3 for the amount of palladium, and by the presence of at least one alkaline earth metal component in an amount of from 0.003 to 0.03 g/cm^3.
The subject-matter of claim 1 of the second auxiliary request is not anticipated by E1e.

5.6 The article according to claim 1 of the **third auxiliary request** is further distinguished by the feature, according to which the alkaline earth component

includes strontium in an amount of from 0.003 to 0.024 g/cm^3.
The subject-matter of claim 1 of the third auxiliary request is not anticipated by E1e.

5.7 The board is satisfied, that none of the documents representing the state of the art discloses all the features of claim 1 of the second or third auxiliary request in combination.

Thus, the subject-matter of the claims of said auxiliary requests is novel.

6. Inventive step - claim 1 of the second auxiliary request

It remains to be investigated, whether the article according to claim 1 of the second auxiliary request involves an inventive step as required by Articles 52(1) EPC and 56 EPC.

6.1 The invention relates to an arrangement comprising a gasoline engine, a close coupled catalyst and a downstream catalyst. The close coupled catalyst comprises a honeycomb carrier and a catalyst composition comprising an activated alumina support, a palladium component and an alkaline earth metal component, but no cerium component or praesodymium component as oxygen storage component. In contrast, the downstream catalyst comprises a cerium component or a praesodymium component as an oxygen storage component. The arrangement is designed to reduce pollutants in gasoline engine exhaust gas streams, including hydrocarbons, carbon monoxide and nitric oxides, during

"cold starts", i.e. at low temperatures of the engine exhaust gas streams, but also during steady state operation of the engine, when the temperatures of the exhaust gases are high. For this purpose, the close coupled catalyst has to be very reactive at low temperatures of, for example, 350 °C and, simultaneously, thermally stable upon exposure to high temperatures of up to 1100 °C during the operation of the engine (see patent, page 5, lines 5 - 19, 26 - 30).

6.2 The closest prior art is represented by document E1e, because E1e belongs to the same technical field as the patent in suit, i.e. devices for purifying exhaust gases comprising a combustion engine, a close coupled catalyst, and a downstream catalyst. Moreover, E1e addresses the same technical problem, namely to achieve a high purifying performance at both low and high temperatures of the exhaust gas, while avoiding thermal degradation of the catalysts at high temperatures (see E1e, page 3, lines 6 - 21).

6.3 According to the patent in suit, the technical problem underlying the claimed invention consisted in developing an arrangement for the treatment of exhaust gases, comprising a close coupled catalyst having the ability to oxidise a relatively high amount of hydrocarbons and a significant amount of carbon monoxide, as well as a significant amount of nitrogen oxides, at low temperatures (see patent, page 4, lines 57 - 58; page 5, lines 5 - 6, 18 - 19, 26 - 30, 50 - 53). A second aspect of the technical problem was to find a close coupled catalyst composition, which is stable at high temperatures of up to 1100 °C of the exhaust gases (see E1e, page 5, lines 28 - 30). At the

oral proceeding the respondent confirmed, that this was, in fact, the technical problem posed.

6.4 As a solution to said technical problem, the patent in suit proposes an article according to claim 1, comprising a gasoline engine, a close coupled catalyst (20) and a downstream catalyst (24), the close coupled catalyst (20) having a close coupled catalyst composition characterised by the following features:

(i) absence of cerium components and praesodymium components;

(ii) a loading of palladium within the range of from 1.77 to 14.16 kg/cm^3; and

(iii) presence of a relatively small amount of from 0.003 to 0.03 g/cm^3 of at least one alkaline earth metal component.

6.5 The question arises, whether the technical problem as stated by the respondent is effectively solved by the article according to claim 1 over the whole scope of the claim.

6.5.1 This was denied by the appellant at the oral proceedings. The appellant argued, that claim 1 did not exclude the presence of oxygen storage components other than ceria and praesodymia. According to the description of the patent in suit components such as iron, nickel, cobalt, lanthanum, neodymium could be present as optional components without any limitation of their respective amounts. According to the patent in suit, neodymium oxide and lanthanum oxide were even

preferred as components (see patent, claim 2; page 3, lines 36 - 37). Therefore, the absence of any cerium components and praesodymium components did not mean that, overall, the oxygen storage capacity of the close coupled catalyst was reduced. Consequently, there was no limitation of the amount of carbon monoxide oxidation in the close coupled catalyst, which was, however, essential for achieving the required bypass of carbon monoxide in the close coupled catalyst (see patent, page 5, line 51 to page 6, line 3; page 10, lines 39 - 44).

6.5.2 The board concurs *in essence* with the argumentation submitted by the appellant. It is, in fact, plain from the content of the description of the patent in suit, that the technical problem is only solved, when the oxygen storage capacity of the close coupled catalyst composition is significantly lower than in the case of catalyst compositions containing cerium components or praesodymium components. A reduced oxygen storage capacity of the close coupled catalyst is a condition for allowing carbon monoxide to bypass the close coupled catalyst and reach the downstream catalyst (see patent, page 11, lines 8 - 12). The board concludes, therefore, that in the absence of any limitation of the types and amounts of oxygen storage components other than cerium and praesodymium, claim 1 encompasses a whole manifold of embodiments, which do not solve the technical problem.

6.6 Therefore, the technical problem has to be reformulated in a less ambitious manner.

In accordance with the submissions made by the appellant at the oral proceedings, the technical problem can be seen in providing a further arrangement for the treatment of gasoline engine exhaust gases.

The board is satisfied that this problem is plausibly solved.

6.7 It remains to be decided, whether the proposed solution involves an inventive step, or not. In this respect, the decisive question is, whether the state of the art provided hints not to use cerium components and praesodymium components in the close coupled catalyst composition, but to use palladium and at least one alkaline earth metal in the amounts as specified in claim 1.

6.7.1 Starting from the closest prior art represented by E1e, and confronted with the problem of finding an alternative to the arrangement disclosed therein, the skilled person would consider document E12, which belongs to the same technical field as the patent in suit.

E12 deals with a dual catalyst system comprising a close coupled catalyst and a downstream catalyst (see E12, page 145, Figure 2). The catalysts employed were prepared on ceramic monolithic substrates. Experiments with close coupled catalysts having palladium loadings of 2.6 kg/m^3 (2.6 g/L) and 10.6 kg/m^3 (10.6 g/L), respectively, showed the effectiveness of the arrangement regarding the conversion of hydrocarbons, carbon monoxide and nitrogen oxides (see E12, page 149, left hand column, lines 3 - 8 from the bottom; right

hand column, lines 1 - 6 from the bottom: improvement by increasing the palladium loading from 1.7 g/L to 17 g/L; page 152, left hand column, lines 28 - 37; right hand column, Table 6; page 153, left hand column, second and third paragraph). From the results reported in E12, the skilled person will immediately recognise, that the palladium loadings used in E12 are suitable for close coupled catalysts in combination with downstream catalysts.

6.7.2 Document E13 provided a further hint to use such a loading of palladium. E13 is concerned with the performance of an arrangement for the treatment of exhaust gases comprising a close coupled catalyst and a downstream catalyst (see E13, page 180, Figure 1: *"Warm-up Converter"*, *"Underfloor Converter"*). In particular, the reduction of hydrocarbon emissions under *"cold start"* conditions, as well as the impact on the reduction of carbon monoxide and nitrogen oxides were investigated (see E13, page 179, right hand column, lines 4 - 8, 25 - 29). The close coupled catalysts used in E13 were palladium based three-way-catalysts on a honeycomb carrier (*"400 cpsi ceramic substrates"*). They comprised stabilised alumina and ceria with additional base metal promoters (see E13, page 180, left hand column, second paragraph, lines 1 - 4, 13 - 25). The respective palladium loadings were 50 g/ft^3, 100 g/ft^3 and 300 g/ft^3, corresponding to 1.77 kg/m^3, 3.54 kg/m^3 and 10.62 kg/m^3. It was found, that close coupled catalysts having such loadings of palladium were effective, not only regarding the reduction of hydrocarbons, carbon monoxide and nitrogen oxides, but also in respect of the light-off performance (see E13, page 181, right hand column, lines 1 - 7; Figure 2;

page 182, left hand column, lines 1 - 11; Figure 4). The skilled person derives from the experimental results reported in E13, that loadings of palladium of 1.77 kg/m^3 and more are suitable for close coupled catalysts.

6.7.3 As to the absence of cerium components and praesodymium components from the close coupled catalyst composition, reference is made to document E4 disclosing *inter alia* the use of palladium together with an alkali earth metal component. When looking for alternatives to the arrangement disclosed in E1e, the skilled person would consider document E4, because E4 relates to palladium based catalyst compositions for the treatment of exhaust gases comprising a ceramic monolithic carrier and a support of γ-alumina. Ceria or zirconia may be present as further components, but are optional. The catalysts are designed to reduce the levels of carbon monoxide and hydrocarbons of exhaust gases from gasoline engines, typically operated at rich air-to-fuel ratios and at inlet temperatures of 700 °C and peak temperatures of 1300 °C (see E4, claim 1; col. 1, lines 8 - 32). According to E4, the palladium loading is preferably more than 0.53 kg/cm^3 (15 g/ft^3) (see E4, col. 3, lines 27 - 30). The amount of alumina may vary from 0.012 g/cm^3 to 0.3 g/cm^3 (0.2 g/in^3 to 5 g/in^3), preferably from 0.03 g/cm^3 to 0.18 g/cm^3 (0.5 g/in^3 to 3 g/in^3) (see E4, col. 3, lines 21 - 23, 30 - 31). E4 mentions a number of conventional stabilisers for alumina, including the oxides of alkaline earth metals and rare earths, and zirconium oxide (see E4, col. 1, lines 33 - 36).

It was found, that the combination of lanthanum and barium provided a particularly efficient stabilisation of alumina at high temperatures when compared with lanthanum or barium alone or other combinations of rare earth oxides and alkali earth metal oxides (see E4, col. 2, lines 9 - 13; col. 4, lines 7 - 14). Experimental results were given for γ-alumina stabilised with various mixtures of rare earth oxides and alkaline earth metal oxides, including in particular mixtures of 1.65 % by weight of lanthanum oxide with 1.35 % by weight of either barium oxide or magnesium oxide (see E4, col. 6, lines 36 - 47, Example VII; col. 7, line 59 to col. 8, line 22, Table VI).

All in all, the skilled person learns from E4, that palladium based catalysts comprising an activated alumina support and at least one alkaline earth metal component, namely barium, in the amounts set out above, are effective and exhibit a good performance even after exposure to high temperatures of more than 1000 °C (see, for example, E4, claim 1; col. 5, lines 4 - 24, Example III; col. 7, lines 15 - 29, Table III).

6.7.4 Taking the disclosure of either document E12 (page 149, right hand column, line 3 from the bottom: 1.7 g/L to 17.0 g/L) or E13 (page 180, left hand column, Table 1, last three entries *"Warm-up Converters"*) into consideration, the skilled person would realise, that high palladium loadings of 1.77 kg/m^3 or more are suitable and exhibit a good performance in terms of the light-off properties and the reduction of hydrocarbons, carbon monoxide and nitrogen oxides.

Furthermore, considering the disclosure of E4, the skilled person would contemplate to use a support in the form of from 0.03 g/cm^3 to 0.18 g/cm^3 of activated alumina stabilised with barium in an amount of, for example 1.35 %, preferably in combination with lanthanum oxide. The skilled person would, thus, arrive at the subject-matter of claim 1 by considering the disclosures of E1e together with either E12 or E13, and E4.

The board notes, that the close coupled catalyst composition according to example 1 of the patent in suit contains also barium oxide and lanthanum oxide (see patent, page 11, lines 1 - 2).

6.7.5 As to the requirement of the absence of cerium components and praesodymium components from the close coupled catalyst composition, the respondent argued at the oral proceedings, that the skilled person, starting from E1e and taking E12 into consideration, would regard the presence of a cerium component in the close coupled catalyst composition as an essential feature. At the material time, it was generally accepted, that ceria was required in order to achieve a sufficient thermal stability of the active alumina support. Therefore, the skilled person would not have excluded the cerium component from the close coupled catalyst composition. The respondent submitted, that the appellant's allegation to the contrary was based on hindsight. Furthermore, the respondent explained, that the skilled person would not have considered the disclosures of E1e, E12 and E4 in the expectation of some benefit.

6.7.6 The board is not convinced by this argumentation for the following reasons:

As set out above under points 5.2, 5.3 and 5.4, document E1e discloses a close coupled catalyst composition containing no cerium component. Therefore, the skilled person was aware of the possibility of cerium free compositions. Moreover, neither E12 nor E4 require the presence of a cerium component. E12 is satisfied with the incidental and general remark, according to which the alumina washcoat "*typically contains aluminium oxide stabilisers, noble metal dispersion stabilisers, and promoters of the noble metals*" (see E12, page 144, right hand column, lines 9 - 14). As far as E4 is concerned, the stabilisation of γ-alumina is achieved in various manners, especially by means of lanthana and baria. Ceria is not mentioned in E4 as a mandatory component (see E4, col. 2, lines 5 - 9; claim 1).

Further documents disclosing the use of activated alumina supports in combination with catalyst compositions containing no cerium component are E9, E10 and E11. Documents E9 and E10 do not mention cerium as a mandatory component of the catalyst composition (see E9, claim 1 and col. 6, lines 46 - 51. E10, claim 1 and page 10, line 34 to page 11, line 2). Document E11 discloses the use of γ-alumina as support material together with catalyst compositions, wherein cerium is replaced by other oxygen storage components, in particular lanthanum (see E11, col. 6, lines 32 - 43). Having regard to the documents referred to above, the board concludes that, contrary to the view of the respondent, the skilled person was aware of the

possibility of using cerium free catalyst compositions on active alumina supports.

Concerning the issue of whether the combination of E1e, E12 and E4 is based on hindsight, the board observes, that these documents provide information about two distinct technical aspects. Whereas E12 discloses suitable loadings of palladium, E4 gives guidance regarding the amount of the activated alumina support and its stabilisation with alkaline earth metal components. There is no evidence, that these two aspects are interrelated, let alone that they give rise to a synergistic effect. The board concludes, that in the absence of any evidence to the contrary, the effects of the concerned features are independent from each other. Under these circumstances, it is justified to consider these features and their effects separately. Hence, the fact, that in the present case, the skilled person would consider three documents together, namely E1e, E12 (or E13) and E4, does not mean, that the line of action is based on hindsight.

6.8 For the reasons set out above, the board concludes, that the article according to claim 1 of the second auxiliary request does not involve an inventive step.

7. Inventive step - claim 1 of the third auxiliary request

As stated above under point 5.6, the article according to claim 1 of the third auxiliary request is further distinguished by the feature, that the alkaline earth component includes strontium in an amount of from 0.003 to 0.024 g/cm^3.

7.1 The question arises, whether this feature reverses the conclusion of obviousness reached for the second auxiliary request (see above, point 6.8).

7.1.1 In the description of the patent in suit, it is stated that it is known in the state of the art to stabilise alumina supports against thermal degradation by the use of materials such as zirconia, titania, alkaline earth metal oxides such as baria, calcia or strontia, or rare earth metal oxides, such as ceria or lanthana (see patent, page 3, lines 21 - 24, referring to US 4 171 288 A). There is no evidence in the patent in suit, that the use of strontia gives rise to a special technical effect in comparison with other alkaline earth metals, for example baria. No such evidence has been submitted at the oral proceedings either.

7.1.2 Under these circumstances, the board concludes, that the use of strontium in an amount of from 0.003 to 0.024 g/cm^3 is arbitrary and belongs to the normal working practice of the skilled person.

7.2 Therefore, the article according to claim 1 of the third auxiliary request does not involve an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

C. Vodz G. Raths