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) [ ] To Chairmen
(D) [x] No distribution

D E C I S I O N
of 23 May 2003

Case Number: T 0309/00 - 3.2.4

Application Number: 92920904.7

Publication Number: 0560991

IPC: F01N 3/18

Language of the proceedings: EN

Title of invention:
Device for purifying exhaust of internal combustion engine

Patentee:
TOYOTA JIDOSHA KABUSHIKI KAISHA

Opponents:
Robert Bosch GmbH
Ford Global Technologies, Inc.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 83, 84, 100(a), 100(b), 111(1), 123(2)

Keyword:
"Amendments - added subject-matter (no)"
"Claim - clarity (yes)"
"Disclosure - sufficiency - (yes)"
"Novelty - (yes)"
"Inventive step (yes)"
"Remittal - (no)"

Decisions cited:
T 0301/87

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0309/00 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 23 May 2003

Appellant: (Proprietor of the patent)
TOYOTA JIDOSHA KABUSHIKI KAISHA
1, Toyota-cho
Toyota-shi
Aichi-ken 471-8571 (JP)

Representative:
Leson, Thomas Johannes Alois, Dipl.-Ing.
c/o TBK-Patent
P.O. Box 20 19 18
D-80019 München (DE)

Respondent I: (Opponent I)
Robert Bosch GmbH
Abtlg. ZGE1
Postfach 30 02 20
D-70442 Stuttgart (DE)

Respondent III: (Opponent III)
Ford Global Technologies, Inc.
Suite 911
Parklane Towers East
1, Parklane Blvd
Dearborne
Michigan 48126-2490 (US)

Representative:
Lawrence, Peter Robin Broughton
GILL JENNINGS & EVERY
Broadgate House
7 Eldon Street
London EC2M 7LH (GB)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 13 December 1999 revoking European patent No. 0560991 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: C. A. J. Andries
Members: T. Kriner
H. Preglau

Summary of Facts and Submissions

I. The Appellant (Patent Proprietor) lodged an appeal, received at the EPO on 10 February 2000, against the decision of the Opposition Division posted on 13 December 1999 concerning the revocation of the European patent No. 0 560 991. The appeal fee was paid simultaneously and the statement setting out the grounds of appeal was received at the EPO on 13 April 2000.

II. Opposition was filed against the patent as a whole and based on Article 100(a) EPC in conjunction with Articles 52(1), 54(1), 56 EPC and on Article 100(b) EPC in conjunction with Article 83 EPC.

In its decision the Opposition Division held that the subject-matter of claim 1 as granted was not new with respect to the state of the art as represented by each of the following documents:

F1: SAE Paper 780607 (=B13)

F2: SAE of Japan, Paper 882087

F5: EP-A-0 351 197, and

F7: EP-A-0 272 136.

Therefore the subject-matter of the patent in suit did not satisfy the requirements of Article 52(1) and 54 EPC.

III. In addition to these documents the following documents played a role in the appeal proceedings:

F3: JP-A-62/117620 (in English)

F8: JCCCAT (17), 1990, pages 1165 and 1166

F9: SAE Paper 881595 (=B14)

B11: JP-A-62/106826 (in English)

D20: Taylor et al., "Behavior of Automobile Exhaust Catalysts with Cycled Feedstreams", Industrial & Engineering Chemistry Product Research and Development, Vol. 22, March 1983, pages 45 - 51

D39: EP-A-0 540 280.

IV. Oral proceedings took place on 16 May 2003.

The Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the main request or one of the auxiliary requests 1 to 6, all filed during the oral proceedings.

The Respondents I and III (Opponents I and III) requested that the appeal be dismissed.

The Respondent III additionally requested that the case be remitted to the first instance or that the appeal proceedings be continued in writing, if the Board intended to assess inventive step of the claimed subject-matter.

At the end of the oral proceedings the discussion was closed. The decision was announced orally in the reopened oral proceedings on 23 May 2003.

V. Claim 1 of the main request for the designated Contracting States ES, IT, SE (claim 1, version A) reads as follows:

"An exhaust purification device of a lean burn internal combustion engine (1) comprising an NO_x absorbent (18) disposed in an exhaust passage (17) of said engine (1), wherein the exhaust gas continuously flows into the NO_x absorbent (18) during an operation of said engine (1), wherein said absorbent (18) comprises a catalyst, and absorbs NO_x when the exhaust gas is lean and releases said absorbed NO_x when the oxygen concentration of the exhaust gas is lowered, so that, when the exhaust gas is rich or the stoichiometric air-fuel ratio, unburned HC and CO in the exhaust gas react with the released NO_x to thereby reduce the NO_x."

Claim 1 of the main request for the designated Contracting States DE, FR, GB (claim 1, version 1) reads as follows:

"An exhaust purification device of a lean burn internal combustion engine (1) comprising an NO_x absorbent (18) disposed in an exhaust passage (17) of said engine (1), wherein the exhaust gas continuously flows into the NO_x absorbent (18) during an operation of said engine (1), wherein a lean air-fuel mixture is continuously burned and said absorbent (18) comprises a catalyst, and absorbs NO_x when the exhaust gas is lean and releases said absorbed NO_x when the oxygen concentration of the

exhaust gas is lowered, wherein release of absorbed NO_x takes place when the air-fuel ratio of the inflowing exhaust gas is rich and when the air-fuel ratio is stoichiometric, wherein the air-fuel ratio of the exhaust gas is made rich or stoichiometric when a constant amount of NO_x is absorbed in the NO_x absorbent (18), to release the absorbed NO_x from the NO_x absorbent (18), so that, when the exhaust gas is rich or the stoichiometric air-fuel ratio, unburned HC and CO in the exhaust gas react with the released NO_x to thereby reduce the NO_x, wherein the NO_x-release processing is not carried out until the temperature (T) of said NO_x absorbent (18) becomes equal to or larger than a predetermined temperature (T1)."

VI. In support of his main request the Appellant relied essentially on the following submissions:

The claimed exhaust purification device had to be regarded as a system comprising a lean burn internal combustion engine including an exhaust passage, a motor management system for controlling the air-fuel ratio, and a NO_x absorbent. These elements were implicitly defined by the features of the present claims, in particular by the features beginning with the expression "wherein".

The NO_x absorbent was a device which was sufficiently defined by its arrangement and its function, ie its arrangement in the exhaust passage so that the exhaust gas continuously flew into the NO_x absorbent, and its ability to absorb NO_x when the exhaust gas was lean and to release the absorbed NO_x when the oxygen concentration of the exhaust gas was lowered. The

expression "NO_x absorbent" was a current technical term and defined a device which was able to store NO_x within the material of the absorbent and not only on its outer surface or on the surface of micro pores contained in the material of the absorbent. Such a NO_x absorbent had nothing to do with a three-way-catalyst or a NO_x adsorbent. While a three-way catalyst mainly converted NO_x, and at best stored a minor amount of NO_x at its surface, a NO_x adsorbent was only suitable to store NO_x at its surface. As a result of the storage of NO_x within the whole volume of an absorbent or only on the surface of an adsorbent, a NO_x absorbent and a NO_x adsorbent could be distinguished by the amount of the stored NO_x. As shown in Figures 5(A), 5(B) and in the corresponding description of the patent in suit, the NO_x absorbent comprised a catalyst, such as for example Pt, which was necessary for oxidising the NO_x so that it could be absorbed into the material. Although the NO_x absorbent additionally had the function of a reduction catalyst, this function was not necessary, since it was also possible to reduce the NO_x released from the absorbent by a separate catalyst downstream of the NO_x absorbent.

NO_x absorbents were well known to the skilled person and were described for example in F3, B11 or F8, and in column 14, lines 16 to 46 of the present patent specification. The NO_x absorbent according to the patent in suit differed from the known absorbents only in the way how the NO_x was released from the absorbent, namely by operating the combustion engine at a rich or stoichiometric air-fuel ratio. F3 gave a clear indication that the NO_x absorbent disclosed in this document comprised a catalyst for oxidising the NO_x before it was absorbed. Hence the skilled person had

enough information for the provision of a NO_x absorbent which was suitable for the claimed exhaust purification device.

The subject-matter of version A and version 1 of claim 1 was not disclosed by any of the available documents. All of the documents F1, F2, F5, F7 and F9 referred to exhaust purification devices which comprised a three-way catalyst. This type of catalyst was exclusively used to reduce NO_x at the stoichiometric air-fuel ratio or when the air-fuel ratio was modulated around the stoichiometric air-fuel ratio. However, none of the three-way catalysts disclosed in F1, F2, F5, F7 or F9 was intended for or suitable for absorbing NO_x at a lean air-fuel ratio, and for releasing the absorbed NO_x at a stoichiometric or rich air-fuel ratio. D39 referred to an exhaust purification device which was similar to the one of claim 1, version 1. However, according to D39 the release of absorbed NO_x was controlled solely by the temperature of the NO_x absorbent. Therefore, the subject-matter of claim 1, version A and the subject-matter of claim 1, version 1 was novel over F1, F2, F5, F7, F9 and D39.

The most relevant pre-published state of the art was represented by F3 or B11 which were the only documents referring to an exhaust purification device of a lean burn internal combustion engine comprising a NO_x absorbent. The NO_x absorbent according to F3 or B11 was, however, not regenerated by exhaust gas having a stoichiometric or a rich air-fuel ratio. Since this feature was not known from any of the present documents, the subject-matter of claim 1, version A and

the subject-matter of claim 1, version 1 was also based on an inventive step.

VII. The Respondents disputed the views of the Appellant.

1. The arguments of the Respondent I can be summarized as follows:

Absorption was a mixture of adsorption and absorption which was not at all clear. This was even admitted in the patent in suit. Therefore the skilled person could not distinguish a NO_x absorbent from a NO_x adsorbent, and the claimed NO_x absorbent could only be regarded as a means for storing NO_x.

Since the patent in suit did not give a clear teaching how the desired NO_x absorption effect could be achieved, the claimed invention was not sufficiently disclosed.

Furthermore, claim 1, version A was not new in view of the disclosure of F9. Although this document did not explicitly disclose a device which was capable of absorbing NO_x, it had to be concluded that the catalyst described in F9 inevitably functioned as a NO_x storing device, since Figure 5 showed that this catalyst stored NO_x during a lean phase and released NO_x during a rich phase of the combustion.

If the subject-matter of claim 1, version A was regarded as new, it was at least not based on an inventive step. According to F9, a catalyst had to

be designed so that it sustained a high level of NO_x reduction for a period as long as possible after changing from a rich air-fuel mixture to a lean air-fuel mixture. Since each of F3 and F8 described a catalyst which was suitable for stopping a NO_x release during lean combustion for a relatively long period, it was obvious for the skilled person to replace the catalyst according to F9 by a catalyst according to either of F3 or F8, in order to meet this requirement. This replacement would inevitably lead to the exhaust purification device according to claim 1, version A.

Since F3 additionally suggested a NO_x release processing only within a certain temperature range, the combination of F9 and F3 would also directly lead to the subject-matter of claim 1, version l. Hence, the subject-matter of this claim too did not involve an inventive step.

2. The Respondent III supported his request for dismissal of the appeal by the following arguments:

Although the function of the NO_x absorbent according to the patent in suit was not clear, it appeared that the NO_x absorbent was provided for oxidising NO_x, storing NO_x and reducing NO_x when it was released from the absorbent. Since NO_3 molecules could not penetrate into absorber materials as described in the state of the art and in the patent in suit, but only into the micro pores of these materials, the storage process was

a mere adsorption process. Consequently, the NO_x absorbent according to the patent in suit was at best a NO_x storing device comprising a catalyst for oxidising and reducing NO_x.

With respect to the composition of the NO_x absorbent the patent in suit merely gave the information which elements should be contained in the material of this absorbent. The $MnO_2 \cdot BaCuO_2$ oxide which was described in column 14, lines 16 to 46 had not been described as a NO_x reducer in the priority documents. Documents F3, B11 and F8 which referred to NO_x absorbents did not describe any absorbent which had a reducing function. According to F3 and B11 the NO_x absorbent was reduced in a 100% reducing atmosphere, and F8 was silent about a reducing function of the material described in this document. Therefore the patent in suit described only a concept of an exhaust purification system without describing how this concept could be achieved, and did not disclose the claimed invention in such a way that it could be carried out by a person skilled in the art.

Claim 1, version 1 contained subject-matter which extended beyond the content of the application as filed and therefore did not meet the requirements of Article 123(2) EPC. The originally filed documents neither disclosed that a lean air-fuel mixture was continuously burned in the internal combustion engine for which the claimed exhaust purification device was provided, nor that the NO_x-release processing was carried out in dependence on the temperature of the NO_x absorbent. It was

only disclosed that a lean air-fuel mixture and a rich or stoichiometric air-fuel mixture was burned, and that the NO_x-release processing was carried out in dependence on the exhaust gas temperature.

Moreover this claim was not clear, since even a lean burn internal combustion engine could not continuously burn a lean air-fuel mixture.

The subject-matter of claim 1, version A was not new in view of the disclosure of each of the documents F1, F2, F5, F7 and F9. In particular each of F1 and F5 disclosed that a three-way catalyst stored NO_x during lean air-fuel ratios and released and reduced the NO_x during rich air-fuel ratios, and therefore had to be regarded as a NO_x absorbent. This conclusion was furthermore supported by the fact that the catalyst according to F5 comprised a component corresponding to one of the components suggested for the NO_x absorbent according to the patent in suit.

If the subject-matter of claim 1, version A should be regarded as new, it did at least not involve an inventive step. Starting from the state of the art disclosed in F3, the object to be achieved was the provision of an exhaust purification device which worked without switching between two NO_x absorbents. It was obvious that for the achievement of this purpose a NO_x absorbent had to be used which released absorbed NO_x when the exhaust gas had a rich or the stoichiometric air-fuel ratio so that it contained reducing

substances such as HC and CO. Starting from the state of the art disclosed in D20 which on page 50, right hand column, first paragraph, suggested already a cycling of the exhaust air-fuel ratio with an overall lean air-fuel ratio to reduce the NO_x output, the object to be achieved could be regarded as to slow down the cycling frequency by using a better material for the catalyst. The selection of a suitable material could be done by the skilled person without the exercise of inventive step.

The subject-matter of claim 1, version 1 was not new in view of D39. This document disclosed, in particular in Figures 7 to 10 and in the corresponding description (column 9, line 53 to column 14, line 16) an exhaust purification device having all features of this claim.

With respect to the question of inventive step of claim 1, version 1, the Respondent III did not make any comments. Instead he requested that the case be remitted to the first instance for evaluation of inventive step of all claims, since inventive step had not been considered by the Opposition Division, and since the new claims had been filed so late that an appropriate preparation of arguments against these claims had not been possible.

Reasons for the Decision

1. The appeal is admissible.

2. *The wording of the claims*

2.1 Having regard to the different interpretations of the wording of the present independent claims by the parties, it is necessary to establish the meaning of the claims. In particular it has to be established which elements are comprised by the claimed exhaust purification device, what is defined by the expression "NO_x absorbent", and what is meant by the expression "said absorbent comprises a catalyst".

2.2 According to the versions A and 1 of claim 1, the only element which is explicitly described as comprised by the claimed exhaust purification device is a NO_x absorbent. However, the features present in both versions and referring to the arrangement of the NO_x absorbent, to the continuous flow of exhaust gas into the NO_x absorbent, to the release of absorbed NO_x in dependence on the air-fuel ratio of the exhaust gas, and to the reduction of the released NO_x in dependence on the air-fuel ratio of the exhaust gas, show that the claimed exhaust purification device must additionally comprise an internal combustion engine which is at least capable to provide and to burn a lean air-fuel mixture, an exhaust passage suitable to continuously deliver exhaust gas to the NO_x absorbent, and a motor management system suitable to control the air-fuel ratio of the gas to be burned in the combustion engine.

Therefore the Board agrees with the Appellant's statement that the exhaust purification system defined in claim 1 according to version A and version 1 implicitly comprises at least all these elements.

2.3 At the filing date of the patent in suit the skilled person knew three different methods for the removal of NO_x from exhaust gas, ie catalytic reduction of NO_x, NO_x adsorption and NO_x absorption (see for example F3, page 3, paragraph 3 to page 5, paragraph 2).

The catalytic reduction method is normally used for reducing NO_x in a reducing atmosphere and in the presence of a catalyst. The removal of NO_x from the exhaust gases of an internal combustion engine requires an atmosphere containing almost no oxygen, or in other words exhaust gases having a rich or stoichiometric air-fuel ratio (see F3, page 3, last paragraph). This method is mainly used in three-way catalysts which simultaneously convert HC, CO and NO_x, by oxidising HC and CO, and reducing NO_x.

For the removal of NO_x from exhaust gases having a lean air-fuel ratio, NO_x absorption and NO_x adsorption methods can be used. While in case of adsorption NO_x is only adsorbed onto the surface of the material of an adsorbent, NO_x is absorbed into the material of the absorbent in the case of absorption (see F8, first page, left hand column, last paragraph).

It is correct that the patent in suit admits that the exact mechanism of the absorption is not clear (see column 5, lines 11 to 16). However, for the provision of a NO_x absorbent as described in the present claims, the knowledge of this mechanism is not at all necessary. For this purpose it is sufficient to know the essential function of a NO_x absorbent, ie the absorption of NO_x. In view of this function the skilled

person can very well distinguish a NO_x absorbent from a NO_x adsorbent. NO_x absorbents and NO_x adsorbents use different materials (adsorbents: see F3, page 5, paragraph 2; absorbents: see F3, page 8, first paragraph, and page 9, paragraph 4; and F8, first page), and the amount of NO_x stored in an absorbent is several times larger than the amount of NO_x stored in an adsorbent (see F8, first page, left hand column, last paragraph).

The statement of the Respondent III that NO_3 molecules could not penetrate into absorber materials as described in the state of the art and in the patent in suit, but only into the micro pores of these materials, is not convincing, since this statement is not supported by any evidence, and since F8 which is a scientific paper clearly describes an absorption of NO_x into BaO-CuO binary oxides and not an adsorption on any surface of this material, including the surface of micro pores within the material.

With respect to the above findings, the "NO_x absorbent" according to the present claims cannot only be regarded as a means for storing NO_x, but has to be regarded as a device which absorbs NO_x into the material of the absorbent.

2.4 With regard to the feature according to which the absorbent comprises a catalyst, the description of the patent in suit shows that this means that the absorbent comprises a catalyst like Pt. When the air-fuel ratio of the exhaust gas is lean this catalyst oxidises the NO contained in the exhaust gas to NO_3 which can be absorbed into the absorbent (see Figure 5(A) and

column 5, lines 24 to 36). Additionally the catalyst may be used for reducing the NO_x released from the absorbent when the air-fuel ratio of the exhaust gas is made rich (see column 6, lines 29 to 33). However, while it is indispensable that the catalyst oxidises the NO_x so that it can penetrate into the absorbent, a reduction of the released NO_x is not absolutely necessary, since it could also be reduced downstream of the NO_x absorbent (see column 6, lines 45 to 55).

Therefore, the expression "said absorbent comprises a catalyst" has to be understood so that the absorbent comprises a catalyst for oxidising NO_x.

3. *Amendments*

3.1 Claim 1, version A differs from claim 1 as granted essentially in that it refers to an exhaust purification device of a **lean burn** internal combustion engine, and in that the expression "characterized in that" has been replaced by "wherein".

Claim 1, version 1 differs from claim 1 as granted additionally by the addition of the features according to which

(a) a lean air-fuel mixture is continuously burned;

(b) release of absorbed NO_x takes place when the air-fuel ratio of the inflowing exhaust gas is rich and when the air-fuel ratio is stoichiometric;

(c) the air-fuel ratio of the exhaust gas is made rich or stoichiometric when a constant amount of NO_x is absorbed in the NO_x absorbent, to release the absorbed NO_x from the NO_x absorbent;

(d) the NO_x-release processing is not carried out until the temperature of said NO_x absorbent becomes equal to or larger than a predetermined temperature.

The granted claims 2 to 31 have not been amended, and the description has only been adapted to the amended independent claim 1, versions A and 1.

3.2 The provision of the claimed exhaust purification system for a lean burn engine is disclosed in column 8, lines 4 to 13, and 50 to 57 of the originally filed and published application (EP-A-0 560 991). This section clearly shows that such an engine burns a lean air-fuel mixture in the majority of the operation regions, and that only exceptionally, during warm-up, acceleration and full load, a rich or the stoichiometric air-fuel mixture is burned. This means for the skilled person in other words that the engine "continuously" burns a lean air-fuel mixture as described in feature a). The Board agrees that the expression "continuously burning a lean air-fuel mixture" could confuse a reader of the claims 1. However, for a skilled person the use of this expression can be accepted in order to be able to make the difference to engines which are cycling between rich and lean with a frequency of about 1 Hz, particularly since also the description of the patent in suit (see column 8, lines 11 to 18) clearly discloses the meaning of this expression by comparing that part of the description with Figures 7(A) and 7(B).

For a skilled person such a cycling cannot be compared with a continuous lean burning. Features b), c) and d) are disclosed in Figure 8 of the originally filed and published application and in the corresponding description (see column 9, line 44 to column 11, line 11 of the published application).

It is true that the originally filed application does not explicitly disclose that the **temperature of the NO_x absorbent** has to be equal or larger than a predetermined temperature before the NO_x-release processing is carried out (feature d), but only that the **exhaust temperature** has to be equal or larger than a predetermined temperature (see column 10, lines 13 to 16). It is, however, well known to the skilled person, and confirmed by a statement in the patent in suit (see column 7, lines 7 to 9) as well as in the originally filed application (see column 7, lines 38 to 41), that the temperature of a device and the temperature of an exhaust gas flowing through this device are essentially the same, and that for the determination of the temperature of such a device normally the exhaust gas temperature is measured. As shown in Figures 1, 10, 14 - 16 and 19 of the originally filed and published application, the temperature of the exhaust gas is also in the present case measured close to the NO_x absorbent. Furthermore, the flow sheets in Figures 8, 17 and 20 use in the respective steps 103, 502 or 702 the predetermined value T1 which according to the description, Figure 6 and claim 28 of the originally filed application unequivocally defines a limit temperature of the NO_x absorbent (see Fig. 6) below which the NO_x absorption is lowered (see claim 28; column 25, lines 13 to 16; column 11, lines 5 and 6;

and column 19, lines 51 to 58). Therefore the Board does not doubt that the measured temperature essentially corresponds to the temperature of the NO_x absorbent.

3.3 With respect to the above findings the Board is convinced that the documents according to the main request meet the requirements of Article 123(2) and (3) EPC.

4. *Clarity*

The Board wants to emphasize that the present claims do not describe the claimed device as clearly as would be desirable. In fact, as shown in section 2 above, both claim 1, version A and claim 1, version 1 require an interpretation for understanding their teaching. However, according to the case law of the Boards of Appeal, Article 100 EPC does not allow objections to be based upon Article 84 EPC during opposition proceedings if they do not arise out of amendments made during these proceedings (see T 301/87, OJ EPO 1990, 335). Hence only the question has to be answered whether or not the features which have been added to claim 1 as granted result in a lack of clarity.

With respect to these features a clarity objection has only been made in connection with the feature of claim 1, version 1, according to which a lean air-fuel mixture is continuously burned. However, as shown in section 3.2 above, the skilled person would interpret this feature in such a way that a lean air-fuel mixture is burned in the majority of the operation regions of

the lean burn combustion engine for which the claimed exhaust gas purification device is provided.

Therefore, the modifications made in the claims of the main request do not make these claims unclear (Article 84 EPC).

5. *Sufficiency of the disclosure*

The objection referring to lack of sufficient disclosure of the claimed invention has been justified by the statement that the patent in suit did not give a clear teaching how to design the NO_x absorbent of the claimed exhaust purification system so that the desired absorption effect could be achieved, in particular which material had to be selected for the NO_x absorbent so that it was capable of oxidising NO_x, absorbing NO_x, and reducing NO_x.

As described in section 2.4 above, the NO_x absorbent according to the patent in suit is only provided for oxidising NO_x and absorbing NO_x, whereas a reduction function of this absorbent is not necessarily required. Hence, merely the question arises of whether or not the skilled person was able to design a NO_x absorbent for oxidising and absorbing NO_x at the filing date of the patent in suit. At this time NO_x absorbents were known for example from each of F3, F8 and B11. F3 suggests to make such an absorbent by coating LaFeO3 on a cordierite honeycomb (see page 9, paragraph 4). Furthermore F3 indicates that such an absorbent first oxidises NO_x and then absorbs the NO_x (see page 6, paragraph 2). F8 suggests the use of BaO-CuO binary oxides as a material for a NO_x absorbent. Additionally

the originally filed application of the patent in suit gives the information that a NO_x absorbent can be made by the provision of at least one substance selected from alkali metals, alkali earth metals (such as Ba described in F8), rare earth metals (such as La described in F3), and precious metals on an alumina carrier (see column 15, lines 31 to 36), or by the provision of a composite oxide of an earth alkali metal with copper, as for example $MnO_2 \cdot BaCuO_2$ (see column 15, lines 36 to 41). Moreover, the application indicates that in the first group of substances Pt could be used as a catalyst, while in the $MnO_2 \cdot BaCuO_2$ composite oxide Cu performed the catalytic function (see column 15, lines 43 to 46). The catalyst is described as necessary for oxidising NO before it is absorbed (see column 5, line 48 to column 7, line 33). Therefore the Board is convinced that the skilled person had enough information for providing with a reasonable amount of trial and error a NO_x absorbent as defined in the present claims at the filing date of the patent in suit, particularly since, apart from allegations, no substantial and convincing proof has been brought forward.

With respect to this conclusion and with respect to the fact that all the information in the application set out above is repeated in the patent in suit (see column 14, lines 16 to 30, and column 5, line 26 to column 7, line 2), the patent in suit discloses the claimed invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

6. *Novelty*

6.1 Novelty of the subject-matter of claim 1, version A has been challenged with respect to F1, F2, F5, F7 and F9. All these documents refer to three-way catalysts which are used for simultaneous oxidation of HC and CO, and reduction of NO_x. However, as for example shown in Figure 1 of F1, this simultaneous conversion works only at the stoichiometric air-fuel ratio. At rich air-fuel ratios the oxidation of HC and CO is poor, and at lean air-fuel ratios the reduction of NO_x is poor. With respect to this drawback attempts have been made for widening the air-fuel ratio range in which a sufficient conversion of HC, CO and NO_x is possible, or in other words for widening the so-called selectivity window.

6.1.1 F1 refers to studies of the effect of air-fuel ratio modulation on the widening of the selectivity window. For this purpose the air-fuel ratio of a combustion engine was modulated at a frequency of 1 Hz and at air-fuel ratio amplitudes of 1 and 2 around mid-range air-fuel ratios -$(A/F)_C$ - from 14 to 17. The widening of the selectivity window under air-fuel ratio modulation is described amongst other things as a result of adsorption of NO_x on the catalyst surface during lean air-fuel ratios and a reduction of the adsorbed NO_x during rich air-fuel ratios (see page 119, abstract; and page 125, left hand column, lines 7 to 19 and Figure 13).

With respect to the modulations of the air-fuel ratio at a frequency of 1 Hz, the combustion engine used for the studies according to F1 cannot be regarded as a lean burn internal combustion engine. Such a lean burn

engine operates (as much as possible) continuously at high air-fuel ratios which are normally greater than 18 (see for example F5, page 2, lines 9, 10; F9, page 1, right hand column). Furthermore, the adsorption of NO_x on the three-way catalyst during the lean burn phases of the engine does not justify defining the three-way catalyst as a NO_x absorbent.

Therefore F1 discloses at best an exhaust purification device of an internal combustion engine comprising a NO_x storing and reducing device disposed in an exhaust passage of said engine, wherein the exhaust gas continuously flows into the NO_x storing and reducing device during an operation of said engine, wherein said NO_x storing and reducing device comprises a catalyst (usual in three-way catalysts), and stores NO_x when the exhaust gas is lean and releases said stored NO_x when the oxygen concentration of the exhaust gas is lowered. This storing and releasing takes place during the different periods of the engine air-fuel ratio modulation cycle.

However, F1 does not disclose an exhaust purification device of a **lean burn** internal combustion engine comprising an NO_x **absorbent**, wherein unburnt HC and CO in the exhaust gas react with the released NO_x to thereby reduce the NO_x, when the exhaust gas is rich or has the stoichiometric air-fuel ratio.

6.1.2 F2 refers to studies of the transient reaction mechanism of three-way catalysts. For these studies a sample gas was flown through a three-way catalyst, and the air-fuel ratio of the sample gas was changed stepwise see page 1, section 1). With respect to the

catalytic reactions during the air-fuel ratio changes, the authors of F2 assume that the three-way catalyst described in F2 absorbs NO_x, when the sample gas is hold for a long time at an air-fuel ratio of 14,5 (see pages 3 and 4, section 3.2.1).

However, even if the three-way catalyst according to F2 therefore were regarded as an NO_x absorbent, this absorbent would not absorb NO_x when the exhaust gas is lean and release said absorbed NO_x when the oxygen concentration of the exhaust gas is lowered, as required by claim 1, version A.

Furthermore, since F2 does not describe the use of the three-way catalyst in connection with any combustion engine, this document does not disclose an exhaust purification device of a lean burn internal combustion engine, wherein a NO_x absorbent is disposed in the exhaust passage of this engine.

6.1.3 F5 discloses an exhaust purification device of a lean burn internal combustion engine comprising a three-way catalyst disposed in an exhaust passage of said engine, wherein the exhaust gas continuously flows into the three-way catalyst during an operation of said engine (see claim 1, and page 3, lines 40 to 43).

There is, however, no indication in F5 that the three-way catalyst according to F5 is intended to absorb NO_x or works as a NO_x absorbent, let alone in the way as described in version A of claim 1, ie that it absorbs NO_x when the exhaust gas is lean and releases the absorbed NO_x when the oxygen concentration of the exhaust gas is lowered. The mere fact that the catalyst

of F5 contains platinum and an oxide of the metals described in claim 4 of the patent in suit (see page 3, lines 8 to 12) does not allow one to conclude that it therefore inevitably works as an absorbent, in particular since the lanthanum-barium-cobalt oxide disclosed in F5 (see page 3, lines 10 to 12) is only one out of several components of the three-way catalyst, and is provided for storing oxygen.

6.1.4 F7 discloses an exhaust purification device of an internal combustion engine comprising a three-way catalyst disposed in an exhaust passage of said engine, wherein the exhaust gas continuously flows into the catalyst during an operation of said engine (see page 2, lines 1 to 4).

However, there is no indication in F7 that the exhaust purification device is provided for a lean burn internal combustion engine, and that the three-way catalyst is intended as a NO_x absorbent or works as a NO_x absorbent.

As already set out in section 6.1.3 above, the mere fact that the catalyst of F7 contains a rare earth metal (see page 3, line 52 to page 4, line 2) as described in claim 4 of the patent in suit does not allow one to conclude that it therefore inevitably works as an absorbent, in particular since F7 does not describe any effect of this metal on the capability of the catalyst for storing NO_x.

6.1.5 F9 refers to the combination of a three-way catalyst and an engine control strategy for lean-burn engine operation which controls the degree and duration of

enrichment of the air-fuel mixture during acceleration (see page 1, abstract). Comparative tests which mainly concern the conversion efficiency of a Pt/Pd catalyst, a PT/Rh catalyst, a concept A catalyst, and a concept B catalyst are presented. Concept catalysts A and B are designed to sustain a high level of NO_x reduction for a period which is as long as possible after changing from a rich air-fuel ratio to a lean air-fuel ratio (see page 2, left hand column, paragraph 4, section b).

With respect to claim 1, version A, F9 discloses an exhaust purification device of a lean burn internal combustion engine comprising a three-way catalyst disposed in an exhaust passage of said engine, wherein the exhaust gas continuously flows into the catalyst during operation of said engine (see page 3, table 2).

However, there is no indication in F9 that this exhaust purification device is intended as a NO_x absorbent or works as a NO_x absorbent.

The argumentation of Respondent I that the catalyst described in F9 inevitably has to function as an NO_x absorbent is not convincing. Figure 5 shows that the concept A catalyst has an improved NO_x conversion efficiency as compared with a conventional Pt/Rh three-way catalyst. This improvement results from the maintenance of a high NO_x conversion after returning from a rich air-fuel ratio to a lean air-fuel ratio (see page 6, left hand column, paragraph 1). Figure 5 does, however, not allow one to conclude that NO_x is stored during lean combustion and released during rich combustion. This Figure merely shows that the NO_x conversion efficiency of both the concept A catalyst

and the Pt/Rh three-way catalyst is high during a rich phase of combustion (1 to 2 seconds) and a short period after this phase (less than 1 second) and low during a lean phase of combustion (2 to 8 seconds). Since the NO_x conversion efficiency corresponds to the ratio of the difference between the amount of NO_x fed to the catalyst and the amount of NO_x released from the catalyst to the amount of NO_x fed to the catalyst, the NO_x conversion efficiency would be high if NO_x was stored in the catalyst during the lean phase of combustion. However, since Figure 5 shows that it is low, it has to be concluded that nearly no NO_x is converted or stored in both of the catalysts during the lean phase of combustion.

6.2 Novelty of version 1 of claim 1 has been challenged only with respect to D39 which forms part of the state of the art according to Articles 54(3) and 54(4) EPC. This document discloses (see second embodiment shown in Figures 7 to 11 and described in the corresponding description in column 9, line 53 to column 14, line 16) an exhaust purification device of a lean burn internal combustion engine (52) comprising an NO_x absorbent (56) disposed in an exhaust passage (54) of said engine, wherein the exhaust gas continuously flows into the NO_x absorbent during an operation of said engine, wherein a lean air-fuel mixture is continuously burned and said absorbent comprises a catalyst (see claims 7 and 8), and absorbs NO_x when the exhaust gas is lean and releases said absorbed NO_x when the oxygen concentration of the exhaust gas is lowered, wherein release of absorbed NO_x takes place when the air-fuel ratio of the inflowing exhaust gas is rich and when the air-fuel ratio is stoichiometric (see column 13, line 41 to

column 14, line 14), wherein the air-fuel ratio of the exhaust gas is made rich or stoichiometric to release the absorbed NO_x from the NO_x absorbent, so that, when the exhaust gas is rich or the stoichiometric air-fuel ratio, unburned HC and CO in the exhaust gas react with the released NO_x (in the three-way catalyst 58) to thereby reduce the NO_x, wherein the NO_x-release processing is not carried out until the temperature of said NO_x absorbent becomes equal to or larger than a predetermined temperature (see Figure 9, step 312, and column 12, lines 19 to 43).

However, D39 does not disclose that the air-fuel ratio of the exhaust gas is made rich or stoichiometric when a constant amount of NO_x is absorbed in the NO_x absorbent. In accordance with D39 the air-fuel ratio of the exhaust gas is made rich or stoichiometric when a predetermined time period of a continuing lean burn condition has elapsed, which period is determined by measuring the accumulated engine rotations SNe (see for example column 11, line 50 to column 12, line 7 and Figure 9, steps 304, 306). In comparison with this procedure, the patent in suit suggests the estimation of the amount of absorbed NO_x from the cumulative value of the engine speed (see column 8, lines 37 to 57).

Consequently, the release of NO_x from the absorbent according to D39 is based on a parameter and on means for performing a method for determining this parameter which have nothing in common with the parameter and the means for its determination according to claim 1, version 1.

6.3 With respect to the above findings, the subject-matter of claim 1, version A, and claim 1, version 1, is novel.

7. *Inventive step*

7.1 According to the case law of the Boards of Appeal the closest prior art is normally prior art conceived for the same purpose or having the same objective as the claimed invention and having the most relevant technical features in common (see Case Law of the Boards of Appeal of the European Patent Office, 4th edition, 2001, English version, I.D.3.1, page 102).

In the present case the exhaust purification device according to the patent in suit is provided for absorbing NO_x from the exhaust gas of a lean burn internal combustion engine while a lean air fuel mixture is burned. For this purpose the claimed device comprises a NO_x absorbent which is capable of absorbing NO_x during a lean burn phase of the combustion engine. Consequently, the most relevant state of the art is a device which is also provided for absorbing NO_x from the exhaust gas of a lean burn internal combustion engine while a lean air fuel mixture is burned.

7.2 Such a state of the art is represented by each of F3 and B11, the only available documents which, with respect to claim 1 version A and version 1, disclose an exhaust purification device of a lean burn internal combustion engine (F3: see page 2, last paragraph; B11: diesel engine) comprising NO_x absorbents (F3: Figure 1, catalysts A and B; B11: Figure 1, catalysts 1-a and 1-b) each disposed in a different exhaust passage of said engine, wherein a lean air-fuel mixture is continuously

burned. Said absorbents comprise a catalyst (for oxidizing NO_x; F3: see page 6, paragraph 2; B11: see abstract), and absorb NO_x when the exhaust gas is lean.

7.3 The opinion of the Respondents that F9 and D20 represent the most relevant state of the art cannot be shared by the Board.

F9, as does the patent in suit, refers to an exhaust purification device of a lean burn internal combustion engine. This purification system is, however, not provided for absorbing NO_x from the exhaust gas of such an engine while a lean air fuel mixture is burned (see section 6.1.5 above; especially the explanation of Figure 5). F9 merely suggests the use of a three-way catalyst which converts NO_x during a prolonged phase of burning a rich air-fuel mixture and during a short period after reverting to lean operation of the combustion engine.

D20 refers to studies of the behaviour of three-way catalysts as a response to a feedstream which was cycled from oxidising gas blends to reducing gas blends. It was found among other things that a situation might arise, where cycling the exhaust air-fuel ratio with an overall lean air fuel ratio rather than stoichiometric air-fuel ratio might lead to a lower NO_x output when the cycling result is compared with a steady lean operation (see page 50, right hand column, paragraph 1). This finding is based on the fact that the conversion of NO_x at net oxidizing time-average stoichiometries was greater with cycling than with the steady feed (see page 50, left hand column, paragraph 2). Consequently D20 does also not relate to

an exhaust purification system for absorbing NO_x from the exhaust gas of an internal combustion engine.

Since conversion and absorption of NO_x are two completely different approaches for controlling NO_x emissions, it is not plausible that the closest prior art for an improvement of an exhaust purification system which is based on NO_x absorption could be represented by an exhaust purification system which is based on NO_x conversion (see in that respect Case Law of the Boards of Appeal of the EPO, 4th edition, 2001, I.D.3.5, page 104). Therefore F9 and D20 cannot be regarded as representing the most relevant state of the art with respect to the subject-matter of the patent in suit. Moreover, even if considered as such, they would never lead a skilled person in an obvious manner to a different concept, ie absorption.

7.4 According to each of F3 and B11 the exhaust purification device comprises two separate NO_x absorbents. The exhaust gas is guided to one of these absorbents for a predetermined time, and then guided to the other absorbent by a first switch valve (F3: C1; B11: 3). The absorbent not receiving the exhaust gas is regenerated by hydrogen introduced from a hydrogen reservoir (F3: 5; B11: 5) via a second switch valve (F3: C2; B11: 4). It is obvious that the exhaust purification system according to F3 and B11 is complex and that the absorbents are not effectively used.

Therefore, starting from F3 or B11, the object to be achieved by the patent in suit is to provide an exhaust purification device which can efficiently absorb NO_x without a complex construction of the exhaust system

and which can release the absorbed NO_x according to need (see column 2, lines 19 to 23 of the present description of the patent in suit).

7.5 According to claim 1, version A and version 1, this object is achieved at least by the provision of an exhaust purification device wherein the exhaust gas continuously flows into the NO_x absorbent during an operation of said engine, and wherein the absorbent releases said absorbed NO_x when the oxygen concentration of the exhaust gas is lowered, so that, when the exhaust gas is rich or the stoichiometric air-fuel ratio, unburned HC and CO in the exhaust gas react with the released NO_x to thereby reduce the NO_x.

These features are not suggested by the available state of the art.

7.6 The argumentation of the Respondent III according to which the use of a NO_x absorbent which released absorbed NO_x when the exhaust gas had a rich or stoichiometric air-fuel ratio so that it contained substances for reducing the released NO_x, was obvious when the complex system according to F3 should be avoided, is not convincing.

There is no indication in the state of the art that a NO_x absorbent may be recovered by exhaust gas having a rich air-fuel ratio. F3 and B11 both suggest a special reducer for recovering such an absorbent. According to F3 this reducer may be hydrogen, ammonia, carbon monoxide, and methane, wherein hydrogen is described as preferable in view of handling secondary pollution problems (see page 9, paragraph 1), and according to

B11 the reducer is hydrogen. F8 is silent about recovering a NO_x absorbent, and all further available documents do not refer to a NO_x absorbent. Furthermore there is no indication in the state of the art as to how the pair of NO_x absorbents in the exhaust systems shown in F3 or B11 could be replaced by a single NO_x absorbent. In view of this situation it is not justifiable to assume that the arrangement of a single NO_x absorbent in an exhaust system so that the exhaust gas continuously flows into this absorbent during an operation of said engine and the exhaust gas itself is used to release the NO_x by controlling the air-fuel ratio so that it becomes rich or stoichiometric for recovering the NO_x absorbent, is obvious for the skilled person.

8. *Procedural matter*

8.1 Since the patent in suit can be maintained in amended form on the basis of the Appellant's main request, there was no reason to consider of the Appellant's auxiliary requests.

8.2 The request of the Respondent III for remittal of the case to the first instance or for continuation of the appeal proceedings in writing, in case that the Board intended to assess inventive step of the claimed subject-matter, has been reasoned by the facts that the Opposition Division did not consider the question of inventive step and that the new claims were filed so late that an appropriate preparation of arguments against these claims had not been possible.

In accordance with Article 111(1) EPC, second sentence, the Board of Appeal may either exercise any power within the competence of the department which was responsible for the decision appealed or remit the case to that department for further prosecution. With respect to the length of the examining, opposition and appeal proceedings of more than 10 years, and since the Respondent I and the Appellant agreed that the Board should deal with the question of inventive step during the oral proceedings, and since it had been indicated in the annex to the summons to attend oral proceedings that the question of inventive step would be considered during the oral proceedings, the Board decided in the present case not to remit the case to the first instance but to itself assess inventive step during the oral proceedings.

This decision was also based on the specific facts of the present case, namely that the patent could be maintained according to the main request on the basis of claims 1, version A and version 1, that version A of claim 1 corresponds essentially to claim 1 as granted, that version 1 of claim 1 corresponds essentially to claim 1 filed by the Appellant in due time before the oral proceedings and that during the oral proceedings claim 1, version 1 had only been clarified with respect to clarity objections put forward by the Respondent III during the oral proceedings.

The argument that Appellant III was taken by surprise by the modifications during the oral proceedings cannot be followed by the Board. If, as a result from an objection made by a party or even by the Board during the oral proceedings, the claim wording is clarified or

modified by introducing into the claim the only possible interpretation, that party cannot be reasonably be surprised, since the parties should have been aware not only of these interpretations which can even be further limiting, but also of the possibility that such clarifications or modifications would be made. Parties should always be prepared for such situations, particularly if the modifications cannot be considered as the addition of completely new features, but as the clarification or modification of features already present in the claim.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent in the following version:

Claims: claim 1, version A for the designated contracting states ES, IT, SE;
claim 1, version 1 for the designated contracting states DE, FR, GB;
both claims 1 filed as a main request during the oral proceedings on 16 May 2003;
claims 2 to 31 as granted;

Description: columns 1 and 2 filed during the oral proceedings on 16 May 2003;
columns 3 to 18 as granted;

Drawings: Figures 1 to 20 as granted.

The Registrar: The Chairman:

G. Magouliotis C. Andries