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**Datasheet for the decision
of 14 May 2009**

Case Number: T 1948/07 - 3.2.06

Application Number: 99102539.6

Publication Number: 0936349

IPC: F01N 7/00

Language of the proceedings: EN

Title of invention:

Method and system for diagnosing deterioration of NOx catalyst

Patentee:

NISSAN MOTOR COMPANY LIMITED

Opponent:

Ford Global Technologies, Inc.

Headword:

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Relevant legal provisions:

-

Relevant legal provisions (EPC 1973):

EPC Art. 54(2), (3), 56

Keyword:

"Novelty (yes)"

"Inventive step (yes)"

"Procedural violation (no)"

Decisions cited:

-

Catchword:

-



Case Number: T 1948/07 - 3.2.06

D E C I S I O N
of the Technical Board of Appeal 3.2.06
of 14 May 2009

Appellant: NISSAN MOTOR COMPANY LIMITED
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted
19 September 2007 concerning maintenance of the
European patent No. 0936349 in amended form.**

Composition of the Board:

Chairman: P. Alting Van Geusau
Members: G. Pricolo
W. Sekretaruk

Summary of Facts and Submissions

I. The appeal stems from the interlocutory decision of the Opposition Division posted on 19 September 2007 maintaining European patent No. 0 936 349 in amended form on the basis of the sixth auxiliary request filed at the oral proceedings. The main request, corresponding to the maintenance of the patent as granted, was rejected for lack of novelty over each of documents

D1 : EP-A-0 916 941;

D3 : JP-A-07-166851 and translation into English.

As regards the other requests not allowed, the Opposition Division came to the conclusion that the subject-matter claimed therein also lacked novelty over D3. However, the claimed system and method of diagnosing deterioration of a nitrogen oxide catalyst in accordance with the sixth auxiliary request was regarded as involving an inventive step essentially because there was *"nothing in the prior art which could be understood as a hint for the skilled man to take an average of a plurality of calculated rates of change in the detected concentration of the nitrogen oxides in order to compare it with a predetermined reference value"*.

II. The patentee and the opponent each lodged an appeal against this decision. The notices of appeal were received at the EPO on 28 and 29 November 2007, respectively, and the payments of the appeal fee were recorded on these same days. The statements setting out

the grounds of appeal were received at the EPO on 25 and 29 January 2008 respectively.

With its statement of grounds of appeal, the appellant (patentee) requested maintenance of the patent as granted or in amended form according to the enclosed first to fifth auxiliary requests. Furthermore, the appellant (patentee) complained that there had been a procedural violation because the decision under appeal considered claim 1 to lack novelty over D3 although this ground was not discussed during the oral proceedings.

III. In the communication accompanying the summons to oral proceedings, the Board expressed the preliminary opinion that the Opposition Division did not commit the alleged procedural violation, that the findings of the Opposition Division as regards lack of novelty over D1 and D3 in respect of the main request appeared to be correct, and that also document

D4 : JP-A-07-208 151 and translation into English

appeared to be relevant in respect of novelty. As regards the other requests, objections under Article 123(2), (3) and 84 EPC were raised.

IV. Oral proceedings, at the end of which the decision of the Board was announced, took place on 14 May 2009.

The appellant (patentee) requested that the decision under appeal be set aside and the patent be maintained on the basis of the new request dated 14 May 2009

(claims 1 to 6, description columns 1 to 12, both of 14 May 2009, drawings figures 1 to 13 as granted).

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

V. Claim 1 according to the sole request of the appellant (patentee) reads as follows:

"1. Method of diagnosing deterioration of a nitrogen oxide catalyst (22) coupled to an internal combustion engine (10), said catalyst (22) being capable of absorbing nitrogen oxides present in exhaust gas emitted from the engine (10) during lean-burn operation and releasing the nitrogen oxides absorbed when an air/fuel ratio is less than a stoichiometric air/fuel ratio, comprising: detecting concentration of the nitrogen oxides in the exhaust gas passing through the nitrogen oxide catalyst, rates of change in the detected concentration of the nitrogen oxides are calculated a plurality of times over a predetermined period of time after the air/fuel ratio becomes less than the stoichiometric air/fuel ratio; and a representative value derived from the calculated rates of change in the detected concentration of the nitrogen oxides is compared with a predetermined reference value, to determine, in response to the comparison result, that the nitrogen oxide catalyst (22) is deteriorated, characterized in that said representative value including either an average of the calculated rates of change in the detected concentration of the nitrogen oxides, or the calculated rate of change in the

detected concentration of the nitrogen oxides at an inflection point of a characteristic curve thereof."

VI. The arguments of the appellant (patentee) can be summarized as follows:

The cited prior art did not disclose taking as a representative value either an average of the calculated rates of change in the detected concentration of the nitrogen oxides, or the calculated rate of change in the detected concentration of the nitrogen oxides at an inflection point of a characteristic curve thereof. D1, in a particular embodiment, judged deterioration of the catalyst on the basis of an integral value of the detected concentration of the nitrogen oxides over a fixed time. An integral value was different from an average value of the detected concentration of the nitrogen oxides over time. D4, which represented the closest prior art, disclosed calculating the second derivative $D2NR$ with respect to time of the detected nitrogen oxides concentration curve to determine an inflection point thereof. The calculation was made by measuring subsequent values of the nitrogen oxides concentration, calculating the difference DNR between the subsequent values, and then further calculating the difference $D2NR$ between the actual DNR value and the previous DNR value. If $D2NR$ was zero or negative, then it was determined that the inflection point had been reached. Since this method was based on determining whether $D2NR$ was zero or negative, there was no incentive for the skilled person to consider an average of the differences DNR . Moreover, it was not immediately apparent how the method of D4 could be modified by

replacing the measured values of the nitrogen oxides concentration with average values. The same applied to the disclosure of D3, which was based on the same operating principle. D3 moreover was not concerned with diagnosing deterioration of a nitrogen oxide catalyst but only with determining the time for starting the regeneration cycle.

VII. The arguments of the appellant (opponent), as far as they are relevant to this decision, may be summarized as follows:

D1 disclosed all the features of the preamble of claim 1 and also the feature of the characterizing portion according to which the representative value included an average of the calculated rates of change in the detected concentration of the nitrogen oxides. The disclosure in D1 of an integral value of the detected concentration of the nitrogen oxides over a fixed time was indeed a disclosure of a representative value including an average value of the detected concentration of the nitrogen oxides over time. In any case, the above-mentioned feature of the characterizing portion of claim 1 could not support the presence of an inventive step when starting from a method according to the preamble of claim 1, as known from D3 or D4. Using the average of two or more measurement points instead of one measurement point only was a generally known measure in signal processing for reducing the influence of disturbances. The implementation of this measure in the method of D3 or D4 did not pose any practical difficulties.

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*
 - 2.1 The Board is satisfied that the amendments made by the appellant (patentee) meet the requirements of Article 123(2) and (3) EPC. The appellant has not disputed this conclusion. Claim 1 corresponds to the combination of independent granted method claim 11 with dependent granted claims 18 and 19, and dependent claims 2 to 6 correspond to granted dependent claims 12 to 16. In contrast to the set of claims of the patent as granted, including claims directed to a system and claims directed to a method, there are only method claims in the amended set of claims under consideration.
 - 2.2 The description has been adapted to the amended claims and also does not give rise to objections under Article 123(2) EPC.
 - 2.3 The appellant (opponent) submitted that the statement of the problem in paragraph [0010] of the patent was incorrect, because the features distinguishing the subject-matter of claim 1 from the closest prior art D4, acknowledged as such in the patent in suit, did not provide the mentioned effect of improving exhaust gas purification efficiency. As explained hereinbelow (see point 4.4), the distinguishing features generally have the effect of improving the accuracy with which nitrogen oxide concentrations are detected (by reducing the influence of disturbance according to the first alternative and improving accuracy and reduce influence

of errors according to the second alternative). This has as a direct result that the method of diagnosing deterioration is more effective. A more effective method of diagnosing deterioration allows reaction in a more effective manner to the deterioration of the catalyst. A more effective manner of reacting to the deterioration of the catalyst generally allows improving the exhaust purification efficiency. Accordingly, the general statement of the objective of the invention recited in paragraph [0010] of the patent in suit (which paragraph has been amended to refer to a method only) is not incorrect.

3. *Novelty*

- 3.1 Document D1 is a European patent application published after the filing date of the patent in suit and whose priority claims are earlier than those of the patent in suit. Assuming that the priority dates of D1 can be acknowledged, D1 forms part of the state of the art according to Article 54(3) and (4) EPC 1973. D1 discloses a method for diagnosing deterioration of a nitrogen oxide catalyst, in particular occlusion due to accumulation of sulfate or exfoliation of NO_x storage material, see col. 29, lines 30,31 and lines 35-37 and col. 3, par. [0015]. The known method relies on the measurement of the pumping current (IP₂) flowing through a nitrogen oxide sensor, which current is representative of the concentration of nitrogen oxides in the exhaust gas emitted from an engine (see col. 25, lines 30 to 33). In a particular embodiment of D1 regarded by the appellant (opponent) as being prejudicial to the novelty of the subject-matter of claim 1, occlusion of the catalyst is diagnosed based

on an integral value of the pumping current over a fixed time (see col. 35, par. [0114]). However, contrary to the submissions of the appellant (opponent), an integral value of the pumping current, i.e. of the detected concentration of the nitrogen oxides, is not an average of the calculated rates of change of the detected concentration of the nitrogen oxides. Firstly, in the embodiment of D1 under consideration the pumping current is measured but there is no disclosure of calculating a rate of change as in the other embodiments of D1 where a difference $\Delta IP2$ is calculated (see e.g. Fig. 5, step S220; see col. 28, lines 29 to 33). Moreover, an integral value corresponds to the area underlying the curve of the concentration of nitrogen oxides over a specific period of time whilst the average value of the curve is a value of nitrogen oxides concentration (which can be calculated by dividing the integral value by the specific period of time).

- 3.2 D3 (reference is made to the English translation) discloses a method for calculating the correct time for starting the regeneration of a nitrogen oxide catalyst. As explained in D3 (see page 10, par. [0015]), in use the catalyst absorbs nitrogen oxides. When it is saturated with nitrogen oxides, these are no longer absorbed and the quality of the exhaust gas deteriorates. Accordingly, a regeneration of the catalyst must be carried out, whereby nitrogen oxides absorbed by the catalyst are released by operating the engine at a rich air/fuel ratio (see page 11, par. [0017]). The absorbing and regeneration cycles are mentioned in the preamble of claim 1 of the patent in suit, which recites that the catalyst is capable of

"absorbing nitrogen oxides present in exhaust gas emitted from the engine during lean-burn operation and releasing the nitrogen oxides absorbed when an air/fuel ratio is less than a stoichiometric air/fuel ratio", i.e. the nitrogen oxides are released when the engine is operated at a rich air/fuel ratio. Since claim 1 aims at "diagnosing deterioration" of a catalyst that is capable of performing both the absorbing and regeneration steps, and since there is no link in claim 1 between the timing of the regeneration step and the intended aim of diagnosing deterioration, the Board takes the view that "*diagnosing deterioration*" must be read in the context of claim 1 as determining when the catalyst's general performance is deteriorated, either in terms of absorbency or regeneration capability. This is in line with the description of the patent in suit (see in particular par.[0003], [0008], col. 6, lines 9 to 13; col. 9, lines 3 to 10; par. [0042]). Thus D3 is concerned with determining the correct time for starting the regeneration but not with diagnosing deterioration of a nitrogen oxide catalyst.

In any case, according to D3 the time for starting the regeneration is calculated, in the embodiment described with reference to Fig. 5, by detecting the inflection point (A) of the curve of the nitrogen oxides concentration over time. This is done (see page 22, par. [0053] and [0054]) by calculating the "*nitrogen oxides concentration increase rate*" $DNR = N_r - N_{r_{i-1}}$ (where N_r is the actual, and $N_{r_{i-1}}$ the previous, nitrogen oxides concentration value) and then calculating the "*change rate of concentration increase rate*" $D2NR = DNR - DNR_{i-1}$ (where DNR_{i-1} is the previous DNR value). If D2NR is zero or negative, then the inflection point has been

reached, whereby the regeneration cycle is started (see page 22, par. [0055]). Accordingly, it is judged that the catalyst is regenerated if DNR is equal or smaller than the previously calculated DNR_{i-1} (i.e. $DNR \leq 0$). This is identical to comparing the actual rate of change DNR with the previous value DNR_{i-1} of the rate of change. Since the previous value DNR_{i-1} can be generally regarded as a predetermined reference value (a "*predetermined*" reference value must not necessarily be a fixed value, it only needs to be determined beforehand), and the actual value DNR can be generally regarded as a representative value derived from the calculated rates of change in the detected concentration of the nitrogen oxides, it can be said that in this embodiment of D3 a representative value (DNR) derived from the calculated rates of change in the detected concentration of the nitrogen oxides is compared with a predetermined reference value (DNR_{i-1}). Then it is determined, in response to the comparison result, whether the nitrogen oxide catalyst must be regenerated or not. However, the representative value DNR is neither an average of the calculated rates of change in the detected concentration of the nitrogen oxides, nor the calculated rate of change in the detected concentration of the nitrogen oxides at an inflection point of a characteristic curve thereof.

- 3.3 D4 (reference is made to the English translation) discloses (see Fig. 2) a method for diagnosing deterioration of a nitrogen oxide catalyst (18; see page 5, first paragraph) coupled to an internal combustion engine, said catalyst being capable of absorbing nitrogen oxides present in exhaust gas emitted from the engine during lean-burn operation and

releasing the nitrogen oxides absorbed when air/fuel ratio is less than a stoichiometric air/fuel ratio (see page 7, par. [0012]), comprising detecting concentration of the nitrogen oxides in the exhaust gas passing through the nitrogen oxide catalyst (18). In the same manner as explained above in respect of D3, D4 discloses calculating a rate of change $DNR = NR - NR_{i-1}$ in the detected concentration of the nitrogen oxides over a predetermined period of time after the air/fuel ratio becomes less than the stoichiometric air/fuel ratio, (see page 16, par. [0048]), and then calculating a rate of change $D2NR = DNR - DNR_{i-1}$. In addition to the method according to D3, the method according to D4 (see the embodiment illustrated in Fig. 5) comprises determining whether the catalyst is deteriorated. This is done by comparing the time at which D2NR becomes zero or negative, i.e. the time at which the inflection point is reached, with a reference value C1 (see page 16, par. [0049]). However, as explained above for the method of D3, the representative value DNR is neither an average of the calculated rates of change in the detected concentration of the nitrogen oxides, nor the calculated rate of change in the detected concentration of the nitrogen oxides at an inflection point of a characteristic curve thereof.

- 3.4 Other documents relevant for novelty have not been cited and are not apparent to the Board. The requirement of novelty (Article 54(2) and 54(3) EPC 1973) is thus met.

4. *Inventive step*

- 4.1 Since document D1 can only be taken into account as prior art under Article 54(3) EPC 1973, it cannot be taken into consideration for judging inventive step (Article 56 EPC 1973, second sentence).
- 4.2 In the Board's view, the closest prior art in respect of the subject-matter of claim 1 is represented by a method according to document D4. In contrast to D3, as explained above, D4 aims at the same objective of the patent in suit of diagnosing deterioration of a nitrogen oxide catalyst.
- 4.3 The subject-matter of claim 1 differs from the method according to D4 by the features defined in the characterising portion, according to which the representative value includes, according to a first alternative, an average of the calculated rates of change in the detected concentration of the nitrogen oxides, or, according to a second alternative, the calculated rate of change in the detected concentration of the nitrogen oxides at an inflection point of a characteristic curve thereof.
- 4.4 The first alternative has the technical effect of reducing the influence of disturbance occurring upon the detection of the nitrogen oxides concentration (see par. [0047] of the patent in suit). The second alternative has the technical effect of allowing increased accuracy and less influence of errors (see par. [0048] of the patent in suit). This was not disputed by the appellant (opponent).

Accordingly, the technical problem solved by the first alternative is to reduce the influence of disturbance occurring upon the detection of the nitrogen oxides concentration and the technical problem solved by the second alternative is to improve accuracy and reduce influence of errors.

- 4.5 As regards the first alternative, it is distinguished from D4 essentially by the same feature which was regarded by the Opposition Division as supporting inventive step (see point I of this decision). The Board accepts the appellant's (opponent) view that, in the field of signal processing, a generally known measure for reducing random noise, i.e. disturbances, is to average the input signal to produce the output signal. However, the appellant (opponent) failed to convince the Board that the implementation of this measure in the method of D4 would lead in an obvious manner to a method falling within the terms of claim 1 of the patent in suit. As submitted by the appellant (opponent) during the oral proceedings before the Board, in order to implement said known measure in the method of D4, the skilled person would need to average a number of points from the input signal representative of the nitrogen oxides concentration NR. However, claim 1 requires that the representative value includes an average of the calculated rates of change in the detected concentration of the nitrogen oxides. These rates of change correspond to the rates of change DNR of D4. Thus, in order to arrive at a method falling within the terms of claim 1 the skilled person would need to average a number of values DNR. This, however, is different from averaging the signal NR.

Since, as explained above, the teaching of D3 does not go beyond that of D4, but is in fact more limited, the above reasoning also applies when taking document D3 as a starting point.

It follows from the above that the appellant's arguments concerning inventive step do not succeed in persuading the Board that the first alternative of claim 1 lacks an inventive step (Article 56 EPC 1973). Nor does the Board see any reason to take a different view.

4.6 As regards the second alternative of claim 1, the appellant (opponent) did not submit any arguments as to why the feature according to which the representative value includes the calculated rate of change in the detected concentration of the nitrogen oxides at an inflection point of a characteristic curve thereof would be obvious. Nor does the board see any reasons which would justify a conclusion that this alternative does not involve an inventive step.

4.7 It follows that claims 1 and 13, together with dependent claims 2 to 12 and 14 to 16, the amended description filed at the oral proceedings, and the drawings as granted, form a suitable basis for maintenance of the patent in amended form.

5. *Procedural violation*

In its grounds of appeal the appellant/patentee referred to an alleged procedural violation committed by the Opposition Division (see point II above). In the communication pursuant to Article 15(1) RPBA annexed to

the summons to oral proceedings, the Board explained that even if D3 was not discussed during the oral proceedings before the Opposition Division in respect of claim 1 as granted (main request), it was discussed in respect of claim 1 of the first auxiliary request. Since the latter was more limited than claim 1 as granted, the finding of lack of novelty over D3 in respect of claim 1 according to the first auxiliary request also applied (*a fortiori*) to claim 1 as granted. Accordingly, no procedural violation could be seen in the fact that the decision under appeal included a finding of lack of novelty over D3, in addition to D1, in respect of claim 1 according to the main request. During the oral proceedings the appellant (opponent) did not comment on this view. The Board therefore does not see any reason to deviate from its provisional opinion which is hereby confirmed.

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Opposition Division with the order to maintain the patent on the basis of:
 - (a) Claims 1 to 6 of 14 May 2009;
 - (b) Description columns 1 to 12 of 14 May 2009;
 - (c) Drawings figures 1 to 13 as granted.

The Registrar:

The Chairman:

M. Patin

P. Alting van Geusau