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D E C I S I O N
of 30 April 2003

Case Number: T 0391/01 - 3.2.4

Application Number: 95110144.3

Publication Number: 0690213

IPC: F01N 7/00

Language of the proceedings: EN

Title of invention:
Exhaust purification device of internal combustion engine

Patentee:
TOYOTA JIDOSHA KABUSHIKI KAISHA

Opponent:
Ford Global Technologies, Inc.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty - yes"
"Inventive step - yes"

Decisions cited:
-

Catchword:
-

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Case Number: T 0391/01 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 30 April 2003

Appellant I: (Opponent)
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)

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

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

Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 29 January 2001 concerning maintenance of European patent No. 0 690 213 in amended form.**

Composition of the Board:

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

Summary of Facts and Submissions

I. The Appellant I (Opponent) lodged an appeal, received at the EPO on 28 March 2001, against the interlocutory decision of the Opposition Division, posted on 29 January 2001, on the amended form in which the European patent No. 0 690 213 can be maintained. The appeal fee was paid simultaneously, and the statement setting out the grounds of appeal was received on 1 June 2001. With his letter of 3 April 2003 the Appellant I withdrew the appeal.

The Appellant II (Proprietor of the patent) likewise lodged an appeal, received at the EPO on 30 March 2001, against the interlocutory decision of the Opposition Division. The appeal fee was paid simultaneously, and the statement setting out the grounds of appeal was received on 29 May 2001.

II. Opposition was filed against the patent as a whole and based on Article 100(a) EPC. The Opposition Division held that the grounds for opposition cited in Article 100(a) EPC did not prejudice the maintenance of the patent as amended according to the auxiliary request 3 filed during the oral proceedings on 18 December 2000.

III. The following documents have been considered during the appeal proceedings:

E2: US-A-3 969 932

E3: US-A-5 088 281

E4: US-A-4 622 809

E5: EP-A-0 444 783
E6: US-A-4 884 066

E7: SAE Paper 780607.

IV. The Appellant II requested that the impugned decision be set aside and that the patent be maintained as granted (main request), or that the patent be maintained on the basis of a first or a second auxiliary request, both filed with letter of 17 December 2001.

V. Claim 1 as granted reads as follows:

"An exhaust purification device of an engine having an exhaust passage, comprising:
an exhaust purification element (18) arranged in the exhaust passage to remove harmful components contained in an exhaust gas, said exhaust purification element (18) having the property that, when an air-fuel ratio of the exhaust gas flowing into said exhaust purification element (18) is changed from lean to rich, an air-fuel ratio of the exhaust gas flowing out from the exhaust purification element (18) is temporarily maintained substantially at the stoichiometric air-fuel ratio and then changed to rich and, at this time, the time during which the air-fuel ratio of the exhaust gas flowing out from the exhaust purification element (18) is maintained substantially at the stoichiometric air fuel ratio becoming shorter as the exhaust purification element (18) deteriorates;
an oxygen concentration sensor (22) arranged in the exhaust passage downstream of said exhaust purification element (18) and producing an output having a level which is proportional to the oxygen concentration in

the exhaust gas;
characterized by
an air-fuel ratio change-over means (11, 39) for temporarily changing the air-fuel ratio of the exhaust gas, which flows into said exhaust purification element (18), from lean to rich for a predetermined fixed time, a peak value detecting means (36, 38) for finding a peak value of the level of the output of said oxygen concentration sensor (22) within said predetermined fixed time during which the air-fuel ratio of the exhaust gas flowing into said exhaust purification element (18) is temporarily maintained at a rich air-fuel ratio by said air-fuel ratio change-over means (11, 39); and
a judgment means for judging a degree of deterioration of said exhaust purification element (18) on the basis of said peak value of the level of the output."

Claim 2 as granted differs from claim 1 as granted only in that the expression "rich" is replaced throughout the whole claim by "lean" and vice versa.

Claims 1 and 2 of the auxiliary requests differ from claims 1 and 2 as granted by additional features.

VI. In support of his requests, the Appellant II relied essentially on the following submissions:

The subject-matter of granted claims 1 and 2 was novel over all cited prior art documents, since none of these documents was able to teach the temporary maintenance of the air-fuel ratio at a rich or a lean air-fuel ratio and the detection of a peak value of the level of the output of the oxygen concentration sensor during this predetermined fixed time period during which the

air-fuel ratio was maintained at a certain value. The peak values which were taken into consideration in documents E4 to E6 were no peak values measured during the maintenance of the air-fuel ratio at a certain value, but peak values which appeared when the air-fuel ratio was changed.

Since granted claims 1 and 2 comprised features which were not at all known from the cited prior art documents, a combination of any of the present documents could not lead to the claimed device. Hence, the subject-matter of granted claims 1 and 2 was also based on an inventive step.

Reasons for the Decision

1. The appeal is admissible

2. *Novelty - Main request*

2.1 E2 discloses an exhaust purification device of an engine having an exhaust passage, comprising:

an exhaust purification element (20) arranged in the exhaust passage to remove harmful components contained in an exhaust gas, which exhaust purification element inherently has the property that, when an air-fuel ratio of the exhaust gas flowing into said exhaust purification element is changed from lean to rich (or from rich to lean), an air-fuel ratio of the exhaust gas flowing out from the exhaust purification element is temporarily maintained substantially at the stoichiometric air-fuel ratio and then changed to rich (or lean) and, at this time, the time during which the

air-fuel ratio of the exhaust gas flowing out from the exhaust purification element is maintained substantially at the stoichiometric air fuel ratio becoming shorter as the exhaust purification element deteriorates;

an oxygen concentration sensor (28) arranged in the exhaust passage downstream of said exhaust purification element and producing an output having a level which is proportional to the oxygen concentration in the exhaust gas; and

an air-fuel ratio change-over means (27, 16) for temporarily changing the air-fuel ratio of the exhaust gas, which flows into said exhaust purification element, from lean to rich (or from rich to lean)[see claim 2, and description, column 3, lines 13 to 18].

However, the exhaust purification device according to E2 neither comprises

a peak value detecting means for finding a peak value of the level of the output of said oxygen concentration sensor within said predetermined fixed time during which the air-fuel ratio of the exhaust gas flowing into said exhaust purification element is temporarily maintained at a rich (or a lean) air-fuel ratio by said air-fuel ratio change-over means, nor

a judgement means for judging a degree of deterioration of said exhaust purification element on the basis of said peak value of the level of the output.

Furthermore, E2 does not disclose that the air-fuel ratio change-over means changes the air-fuel ratio of

the exhaust gas for a predetermined fixed time.

According to E2 the degree of deterioration of the exhaust purification element (20) is determined by measuring the time delay between the occurrence of the change of the output signals from the oxygen concentration sensor (22) upstream of the exhaust purification system and the oxygen concentration sensor (28) downstream of the exhaust purification system, after a change of the air fuel ratio of the exhaust gas by the air-fuel ratio change-over means (27, 16).

2.2 E3 refers to an exhaust purification device of an engine having an exhaust passage, comprising:

an exhaust purification element (12) arranged in the exhaust passage to remove harmful components contained in an exhaust gas, which inherently has the property that, when an air-fuel ratio of the exhaust gas flowing into said exhaust purification element is changed from lean to rich (or from rich to lean), an air-fuel ratio of the exhaust gas flowing out from the exhaust purification element is temporarily maintained substantially at the stoichiometric air-fuel ratio and then changed to rich (or lean) and, at this time, the time during which the air-fuel ratio of the exhaust gas flowing out from the exhaust purification element is maintained substantially at the stoichiometric air fuel ratio becoming shorter as the exhaust purification element deteriorates;

an oxygen concentration sensor (15) arranged in the exhaust passage downstream of said exhaust purification element and producing an output having a level which is proportional to the oxygen concentration in the exhaust

gas; and

an air-fuel ratio change-over means (10, 7) for temporarily changing the air-fuel ratio of the exhaust gas, which flows into said exhaust purification element, from lean to rich (or from rich to lean) for a predetermined fixed time (see for example claims 7 and 8).

However, the exhaust purification device according to E3 does not comprise

a peak value detecting means for finding a peak value of the level of the output of said oxygen concentration sensor within said predetermined fixed time during which the air-fuel ratio of the exhaust gas flowing into said exhaust purification element is temporarily maintained at a rich (or a lean) air-fuel ratio by said air-fuel ratio change-over means, and

a judgement means for judging a degree of deterioration of said exhaust purification element on the basis of said peak value of the level of the output.

In accordance with E3, the state of deterioration of the exhaust purification device is determined by comparing the period of a time between two switching events (for example between the switching of the air-fuel ratio of the engine and the switching of the oxygen concentration sensor) with a predetermined time.

2.3 Each of the documents E4, E5 and E6 discloses

an exhaust purification device of an engine having an exhaust passage, comprising:

an exhaust purification element (E4: 4 / E5: 4 / E6: C) arranged in the exhaust passage to remove harmful components contained in an exhaust gas, which exhaust purification element inherently has the property that, when an air-fuel ratio of the exhaust gas flowing into said exhaust purification element is changed from lean to rich (or from rich to lean), an air-fuel ratio of the exhaust gas flowing out from the exhaust purification element is temporarily maintained substantially at the stoichiometric air-fuel ratio and then changed to rich (or lean) and, at this time, the time during which the air-fuel ratio of the exhaust gas flowing out from the exhaust purification element is maintained substantially at the stoichiometric air fuel ratio becoming shorter as the exhaust purification element deteriorates; and

an oxygen concentration sensor (E4: 7 / E5: 6 / E6: 17) arranged in the exhaust passage downstream of said exhaust purification element and producing an output having a level which is proportional to the oxygen concentration in the exhaust gas.

However, none of the exhaust purification devices according to E4, E5 and E6 comprises an air-fuel ratio change-over means for temporarily changing the air-fuel ratio of the exhaust gas which flows into said exhaust purification element, from lean to rich (or from rich to lean) for a predetermined fixed time. Even if the apparatus comprising the oxygen sensor (E4: 5, E5: 5 / E6: 14), the electronic control unit (E4: 6 / E5: 8 / E6: 15) and the fuelling means (E4: 2 / E5: not shown in the Figures / E6: 16) was regarded as an air-fuel ratio change-over means, it would not form part of the exhaust purification system shown in any of E4, E5

and E6, since it merely serves as a separate fuelling apparatus.

As a result of the missing air-fuel change over means, the exhaust purification device according to E4, E5 or to E6 neither comprises a peak value detecting means for finding a peak value of the level of the output of the oxygen concentration sensor within a predetermined fixed time during which the air-fuel ratio of the exhaust gas flowing into said exhaust purification element is temporarily maintained at a rich (or a lean) air-fuel ratio by said air-fuel ratio change-over means, nor a judgement means for judging a degree of deterioration of said exhaust purification element on the basis of said peak value of the level of the output.

In accordance with each of E4 and E5, a deterioration of the exhaust purification element is detected when the amplitude of the signal produced by the oxygen concentration sensor ("peak to peak value") exceeds a predetermined threshold; and in accordance with E6, a deterioration of the exhaust purification element is detected when the air-fuel ratio detected by the sensor (17) exceeds a predetermined value.

2.4 E7 does not disclose an exhaust purification device comprising means for detecting the degree of deterioration of this device. This document refers exclusively to the widening of the selectivity window of a three-way catalyst under air-fuel ratio modulations.

2.5 Therefore, the subject-matter of claims 1 and 2 of the main request (ie as granted) is new with respect to the

above mentioned documents (Article 54 EPC).

3. *Inventive step - Main request*

3.1 The most relevant state of the art is disclosed in E3 which is the sole document that does not only describe an exhaust purification device as defined in the preamble of claim 1 and of claim 2 of the main request, but additionally discloses the first feature of the characterizing portion of both claims, according to which the exhaust purification system comprises an air-fuel ratio change-over means for temporarily changing the air-fuel ratio of the exhaust gas, which flows into said exhaust purification element, from lean to rich (or from rich to lean) for a predetermined fixed time

3.2 Starting from E3, the object to be achieved by the subject-matter of claims 1 and 2 may be regarded as to provide an exhaust purification device capable of accurately detecting the degree of deterioration of an exhaust gas purification element in an alternative way (see patent in suit, column 2, lines 15 to 18).

3.3 This object is achieved by the provision of a peak value detecting means for finding a peak value of the level of the output of said oxygen concentration sensor within said predetermined fixed time during which the air-fuel ratio of the exhaust gas flowing into said exhaust purification element is temporarily maintained at a rich (or a lean) air-fuel ratio by said air-fuel ratio change-over means; and

a judgment means for judging a degree of deterioration of said exhaust purification element on the basis of said peak value of the level of the output.

3.4 Since the provision of such means is not suggested by the available state of the art (see section 2 above), the subject-matter of claim 1 and of claim 2 cannot be regarded as obvious for a person skilled in the art.

4. With respect to the above findings, the subject-matter of claims 1 and 2 is novel and involves an inventive step.

Therefore, the patent in suit can be maintained as granted.

Since the main request of Appellant II is allowable, there is no reason for considering his auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is maintained unamended.

The Registrar: The Chairman:

G. Magouliotis C. Andries