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D E C I S I O N
of 10 January 1996

Case Number: T 0740/93 - 3.2.4

Application Number: 85112425.5

Publication Number: 0184626

IPC: F02D 41/34

Language of the proceedings: EN

Title of invention:
Control method for a fuel injection engine

Patentee:
HITACHI, LTD.

Opponent:
Robert Bosch GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56, 113
EPC R. 67

Keyword:
"Inventive step (yes)"
"Procedural violation (yes)"
"Reimbursement of the appeal fee"

Decisions cited:
-

Catchword:
-

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Case Number: T 0740/93 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 10 January 1996

Appellant: (Proprietor of the patent)
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Respondent: (Opponent)
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Representative:
-

Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 4 June 1993 revoking European patent No. 0 184 626 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: C. A. J. Andries
Members: P. Alting van Geusau
J. P. B. Seitz

Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 184 626 in respect of European patent application No. 85 112 425.5, filed on 1 October 1985, was published on 10 January 1990 (see Bulletin 90/02).

Claim 1 of the patent reads as follows:

"1. A method for controlling the fuel injection into an engine, wherein the following steps are performed in each one of successive computing cycles:

(a) determining a current fuel injection quantity G_{fn} per engine stroke according to the formula

$$G_{fn}=\frac{G_{fen}-1/\tau . M_{fn}}{1-X}$$

wherein

G_{fen}= desired fuel quantity to be supplied to the engine (10),

$1/\tau . M_{fn}$= fuel quantity vaporizing from a film mass quantity M_{fn} deposited on the intake manifold wall (21),

X = portion of the injected fuel quantity G_{fn} which deposits on the said wall (21),

(b) calculating a fuel injection quantity feedback correction factor γ aiming at a stoichiometric air-fuel ratio A/F based on a signal generated by an O_2 sensor (7),

(c) determining a fuel injection pulse width T_i according to the formula

$$T_i = k_i \cdot \overline{\gamma \cdot G_{fn}} \cdot \frac{1}{N} + T_s$$

wherein

k_i = coefficient dependent on the characteristics of the injector (8),

$\overline{\gamma \cdot G_{fn}}$ = actual fuel injection quantity G_{fn} corrected by said factor γ,

N = engine speed,

T_s = fuel injection dead time,

(d) determining the film mass quantity M_{fn+1} for the subsequent computing cycle according to the formula

$$M_{fn+1} = (1 - \frac{1}{\tau} \cdot \Delta T) M_{fn} + X \cdot \Delta T \cdot \overline{\gamma \cdot G_{fn}}$$

wherein ΔT = computing cycle period."

Independent claim 3 relates to an apparatus for controlling the fuel injection into an engine comprising means (a) to (d) to carry out the method steps (a) to (d) respectively of the method claim 1, and wherein said means (a) to (d) are adapted to perform their functions sequentially and repeatedly in each one of successive computing cycles.

II. Notice of opposition was filed on the grounds of Article 100(a) EPC. In respect of an alleged lack of inventive step the opposition was supported *inter alia* by the documents:

D1: SAE- Technical Paper 810494, *C.F. Aquino*, "Transient A/F Control Characteristics of the 5 Liter Central Fuel Injection Engine",

D2: SAE- Technical Paper 790742, *G.H. Czadzeck and R.A. Reid*, "Ford's 1980 Central Fuel Injection System".

III. By a decision which was given at the end of oral proceedings held on 28 January 1992 and issued in writing on 14 February 1992, the Opposition Division revoked the patent.

IV. Notice of appeal was filed against this decision on 24 April 1992 and a written Statement of Grounds of Appeal in accordance with Article 108 EPC was filed on 24 June 1992.

It was established by the then competent appeal Board that the constitution of the Opposition Division was not in conformity with the provisions of Article 19(2) EPC which failure was considered to give rise to a substantial procedural violation. The Board therefore decided that the impugned decision was null and void ab initio and that the case was to be remitted to the first instance. Reimbursement of the appeal fee was also ordered (see decision T 382/92).

V. In response to a communication of the new Opposition Division in which it was asked whether the parties wanted new oral proceedings to be held, the appellant (patentee) and respondent (opponent) requested that the case be decided on the records.

VI. By decision dated 4 June 1993 the Opposition Division in its new composition revoked the patent.

The Opposition Division held the view that, since it was known from D1 that wall wetting was the most important factor influencing A/F-excursions, the skilled person would not only use the model for the open loop control described in D1, but also the more accurate closed loop control as disclosed in D2 and thereby arrive in an obvious manner at the control method according to claim 1 of the patent in suit.

VII. On 11 August 1993 a notice of appeal against the above decision was filed, the appeal fee being paid on the same day.

In accordance with main requests the appellant requested that the decision under appeal be set aside and the opposition filed against the patent be dismissed and that the difference between the current appeal fee and the appeal fee at the time of the first appeal dated 24 April 1992 (1000 DM) be remitted.
Auxiliary requests were also filed.

In the Statement of Grounds of Appeal filed on 14 October 1993 the appellant argued essentially as follows:

Although D1 also related to transient air/fuel control problems, this document essentially dealt with a manifold wall wetting model rather than disclosing a control method using the equation for the current fuel injection quantity G_{fn}, defined in claim 1 or claim 3 of the patent in suit.

The Opposition Division alleged in the decision under appeal that the equation (10) on page 11 of D1 was basically identical to the equation (d) in the independent claims of the patent in suit. However the

known equation did not contain the term ΔT, i.e. the computer cycle period, so that this allegation was also not supported by the facts.

The only control method actually proposed in D1 was the one mentioned in conclusion (1) on page 14, namely the method of heating the manifold.

Furthermore, as could be derived from the right column on page 8 of D2, the known closed loop control system did not control the pulse width in accordance with a fuel injection quantity, but in accordance with a total air mass flowing through the manifold. This was a completely different system for controlling the pulse width than that achieved by the formula (c) in the contested independent claims, which based the pulse width on the fuel injection quantity and not on the air mass flow.

Neither D1 nor D2 suggested how to take wall wetting effects into account in designing a control method or apparatus, in particular no lead was derivable from these documents to the specific control features of the independent claims.

Reimbursement of the difference between the current appeal fee and the appeal fee at the time of the first appeal was considered to be justified because the additional expenditure was the direct result of a substantial procedural violation. In view of the fact that two of the three members of the Opposition Division which issued the second decision dated 4 June 1993 were identical to two of the three members which issued the first decision of 4 February 1992, it was apparent that the two decisions were materially identical.

VIII. In a communication dated 10 March 1995 the Board expressed the provisional opinion that firstly the lack of any reference either explicitly or implicitly to the Appellant's Statement of Grounds of Appeal filed on 24 June 1992, more particularly to the relevant arguments submitted therein, appeared to constitute a substantial procedural violation requiring reimbursement of the appeal fee and secondly the cited prior art did not give a lead to the method defined in claim 1 or to the apparatus defined in claim 3 of the patent in suit and that therefore the patent could be maintained as granted.

IX. The respondent (opponent) did not file any response or request.

Reasons for the Decision

1. The appeal is admissible.

2. *Novelty*

Novelty of the subject-matter of the independent claims 1 and 3 was not contested and follows from the fact that the cited prior art does not disclose a method or apparatus for controlling the fuel injection into an engine in which the fuel injection pulse width is determined on the basis of the formula defined in these claims, incorporating a lambda correction factor for the actual fuel injection amount.

3. *Closest prior art*

3.1 In the Board's opinion, document EP-A-0 069 219(D4), acknowledged in the description of the patent in suit (see page 2, lines 12 to 29) relates to the closest prior art.

This prior art discloses a method and apparatus for controlling the fuel injection into an engine wherein the desired combustion chamber fuel quantity is calculated on the basis of a basic fuel amount, a temperature etc. correction coefficient and an excess air correction coefficient derived from an O_2 sensor (see Figure 3).

3.2 The Opposition Division considered that D1 disclosed the closest prior art. However, D1 does not relate to a method or apparatus for controlling the fuel injection into an engine but rather to a manifold wall wetting model only (see the conclusions on page 14).

Even considering that D1 might hint at active A/F control there is no disclosure derivable from D1 that such a control would be based directly on the formulas disclosed on page 11 of D1. In this respect attention can also be drawn to the paragraph "Conclusions" on page 14 of D1 which lacks any reference to a control directly related to the equations arrived at in the analysis of the fuel reaching the cylinder. Starting from D2 as the closest prior art therefore can only be considered as the result of an ex-post-facto analysis.

4. *Inventive step*

4.1 When compared to the method and apparatus in accordance with claims 1 and 3 of the patent in suit, the essential difference between the subject-matter of the patent in

suit and that disclosed in D4 is that in accordance with the present patent the current (actual) fuel injection quantity itself (G_{fn}) is corrected by the correction factor based on the lambda sensor value (cf. step (c) and also the description of the patent page 2, lines 33 to 37), whereas in D4 it is the desired fuel quantity ("DFC" in the black box in Figure 3, comparable to G_{fen} in the patent in suit) which is corrected, and moreover this is corrected by the lambda sensor value itself.

4.2 Considering the formula (7) for the fuel injection quantity G_f on page 3 of the description of the patent a lambda-correction of the current fuel injection quantity G_{fn} gives a different result when compared to a correction of the desired fuel quantity because of the inherent correction of the additional term representing the fuel quantity supplied to the cylinder by the vaporisation of part of the previously deposited film mass quantity.

4.3 The problem to be solved by the subject-matter of the patent can be seen in the provision of a method and apparatus for controlling the fuel injection into an engine more accurately, as is also indicated on page 2, lines 30 and 31 of the patent in suit.

4.4 This problem is solved essentially by virtue of the fact that the quantity of the film mass deposited on the intake manifold wall is estimated by newly estimating the film mass quantity using the actually injected fuel quantity thereby making it possible to estimate an accurate film mass quantity closer to the actual film mass quantity (see page 5, lines 47 to 50 of the patent in suit).

4.5 None of the cited documents discloses or, in the Board's opinion, can be considered to give a hint to the claimed correction.

D2, considered to be particularly relevant in the opposition proceedings, discloses a conventional closed loop control of the injected fuel amount on the basis of the exhaust air-fuel ratio (AFR) sensor and calculated air mass.

This document lacks any reference to the effects of deposition of fuel on the intake manifold and the subsequent vaporisation of this film mass requiring correction of the injected fuel amount and therefore cannot be considered to be of any help to the skilled person seeking a solution to the underlying problem involved in the present case.

4.6 It is also to be noted that D1, the document considered to be the most relevant by the Opposition Division, in fact relates to further developments in respect of the system disclosed in D2 with a view to examining the various possible causes of A/F excursions (see third paragraph of left hand column on the second page of D1: the paragraph ends with a reference to D2).

Because of this development sequence the Board cannot therefore follow the Opposition Division's view set out in the decision under appeal according to which it would be obvious to control the fuel injection quantity in accordance with the equations disclosed in D2 and correct the actually supplied fuel amount in response to the signal of the O_2 sensor (lambda factor).

In D2 the lambda correction has already been taken into account to provide a basis for a transient compensation scheme and no indications whatsoever are derivable from D1 or any of the cited documents that, for a control system in which account is taken of manifold wall film fuel for the effects of the A/F excursions, a different compensation would lead to a more accurate engine control.

In the decision under appeal it is further stated that it would be illogical only to take into account the lambda feed back control when correcting the injected fuel amount, since a changed fuel quantity must inevitably be considered in the formula for the film mass quantity (page 6 of the decision under appeal, fourth paragraph).

However the teachings of D1 and also those of D4 do not go further than suggesting a particular manner of correction of the fuel injection quantity and not the slightest hint is given in the direction of correction of the manifold film mass quantity. Therefore in respect of this important aspect of the claimed subject-matter the Opposition Division's opinion can only be based on hindsight and is therefore no valid reason for denying the inventive merit of the subject-matter of the independent claims 1 and 3 of the patent in suit.

4.7 It is to be noted that the respondent (opponent) neither filed any request or argument in the present appeal proceedings nor filed a response to the Board's provisional opinion and thus no further arguments on the respondent's side are available for consideration by the Board.

4.8 Summarising, in the Board's judgement, the proposed solution to the technical problem underlying the patent in suit defined in the independent claims 1 and 3 is inventive and therefore these claims, as well as their dependent claims relating to particular embodiments of the invention in accordance with Rule 29(3) EPC, can form the basis for maintenance of the patent (Article 52(1) EPC) in its granted form.

5. *Procedural issues*

5.1 In the present case the appellant's first appeal dated 24 April 1992 was allowed for reason of a substantial procedural violation (faulty constitution of the Opposition Division) and was remitted to the first instance for a new decision by a duly constituted Opposition Division.

With their new decision dated 4 June 1993 the Opposition Division revoked the patent.

5.2 The appellant argued that the higher cost of the present appeal, due to an increase of the appeal fee as from 1 October 1992, was a direct consequence of the substantial procedural violation and that therefore he should be reimbursed at least the difference between the present appeal fee and the former appeal fee (1000DM).

However, in the present case, because of the remittal with the order for further prosecution of the opposition, the first decision became in fact nothing more than a communication and the first Statement of Grounds of Appeal therefore had to be considered as a response to this communication. Under these circumstances and particularly in view of the fact that the two decisions of the different Opposition Divisions - apart from cosmetic amendments - are almost identical

(including the wrong filing date of the claims of the auxiliary request), in the Board's opinion, it has to be determined whether sufficient consideration was given by the new Opposition Division to the appellant's arguments given in said first statement of grounds of appeal. This is to be done, irrespective of the final decision taken and its wording.

5.3 Important points raised by the appellant in respect of the Opposition Division's reasons for lack of inventive step of the subject-matter of claim 1 in the cancelled decision, included in particular grounds as to why the term G_{fen} (desired fuel quantity to be supplied to the engine) and the computer cycle period ΔT would - contrary to the statement in the first (as well as in the second) decision - not be known from D1, being the closest prior art document used as a starting point for the assessment of inventive step in the Opposition Division's decisions.

Furthermore, the incompatibility in respect of the differences of control of pulse width in accordance with fuel injection quantity vice-versa the control in accordance with the total air mass flowing through the manifold (such as disclosed in D2) and the resulting incompatibility of the systems disclosed in D1 and D2, was commented upon in detail with a view to convince the Opposition Division that such combination was not appropriate.

Examining the two decisions for a reference to these important issues raised by the appellant in his first Statement of Grounds of Appeal, the Board finds that both decisions in substance differ only in that on page 7 (of the latter one), two lines were added to the first paragraph, the content of which perhaps could be interpreted as a further substantiation of the

Opposition Division's contention that D1 implicitly disclosed calculation of a current fuel injection quantity on the basis of a desired fuel quantity to be supplied to the engine.

However, neither a reference to the first Statement of Grounds of Appeal, nor a reply to any of the important issues of dispute of the first decision mentioned above can be derived from the second decision currently under appeal, particularly with respect to the term G_{fen} and period ΔT.

5.4 In accordance with Rule 68(2) EPC decisions of the European Patent Office which are open to appeal shall be reasoned. In this respect the Board accepts that reasoning does not mean that all the arguments submitted should be dealt with in detail, but it is a general principle of good faith and fair proceedings that reasoned decisions contain, in addition to the logical chain of facts and reasons on which every decision is based, at least some motivation on crucial points of dispute in this line of argumentation in so far as this is not immediately apparent from the reasons given, in order to give the party concerned a fair idea of why his submissions were not considered convincing.

Although the decision under appeal contains a reasoning as to why the subject-matter of the patent in suit was considered to lack an inventive step and indeed contains references to points of dispute raised in the proceedings up to the first decision, it does not contain any direct reference to the important issues of dispute raised by the appellant in the first Statement of Grounds of Appeal and even when taking into account a possible implicit response to the issue raised in

respect of the calculation of the desired fuel quantity, it fails to comment upon the other issues of dispute, for example why the documents D1 and D2, considered to be incompatible by the appellant, would be combined by the skilled person.

5.5 Having regard to the fact that the present case was sent back to the first instance for reasons of a procedural violation with the order for further prosecution by a correctly composed Opposition Division, it should have been guaranteed by the new Opposition Division that in this specific case all the important points of dispute raised during the proceedings, particularly the points raised in the first Statement of Ground of Appeal were fully considered on their merits and that the Opposition Division's considerations in their respect were apparent from the decision (cf. the approach indicated in T 735/90, section 6, 3rd paragraph). Since these conditions are not fulfilled, in the Board's judgment the decision does not meet the requirements of Rule 68(2) EPC in that it is not sufficiently reasoned, which failure amounts to a substantial procedural violation.

5.6 In view of the substantial procedural violation the Board considers it to be equitable in the present case to reimburse the appeal fee in its entirety (Rule 67 EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is maintained unamended.

3. The appeal fee is reimbursed.

The Registrar: The Chairman:

N. Maslin C. Andries