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D E C I S I O N
of 20 June 1995

Case Number: T 0220/91 - 3.2.4

Application Number: 83102017.7

Publication Number: 0087809

IPC: F02D 41/18

Language of the proceedings: EN

Title of invention:
Electrical fuel injector control

Patentee:
Hitachi, Ltd.

Opponent:
Robert Bosch GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
T 0229/85; G 0001/84

Catchword:
-

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Case Number: T 0220/91 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 20 June 1995

Appellant: (Proprietor of the patent)
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Representative:
-

Decision under appeal:
Decision of the Opposition Division of the European Patent Office dispatched on 28 January 1991 revoking European patent No. 0 087 809 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: R. E. Gryc
Members: M. G. Hatherly
J. P. B. Seitz

Summary of Facts and Submissions

I. The decision of the Opposition Division to revoke European patent No. 0 087 809 (resulting from application No. 83 102 017.7) was dispatched on 28 January 1991.

The Opposition Division decided that the subject-matter of each of the claims then on file lacked an inventive step over the state of the art represented by:

D1: US-A-4 280 189
D2: US-A-4 214 306
D3: GB-A-1 449 491

II. On 15 March 1991 the Appellant (Proprietor) filed an appeal against this decision. The appeal fee was paid on the same day and the Statement of Grounds of Appeal was received on 7 June 1991.

III. In the appeal proceedings, the Appellant argues essentially as follows:

The invention teaches filtering the engine intake air amount signal or engine speed signal with a first filter coefficient when the engine is idling (as unambiguously defined by conditions I to IV in Claims 1 and 2) and with a second filter coefficient when the engine is in a normal driving state.

D1 discloses different filter coefficients for input signals but not when these different coefficients should be used.

While D2 and D3 teach the use of different filter effects, neither discloses switching therebetween dependent on idling and each relates to a different problem and a different solution to those of the invention.

IV. The Respondent (Opponent) argues in the appeal proceedings essentially as follows:

D1 does not disclose when and why the different filter coefficients should be used and so leaves open the question of how to achieve the desired optimal control of the engine.

To suppress fluctuation to improve engine operating behaviour without affecting acceleration, D3 teaches filtering the engine air amount signal to a greater degree in stationary operating conditions than outside these conditions.

D2 describes filtering the engine speed signal below an engine speed threshold to avoid mechanical vibration. To retain rapid response to changes, no filtering is performed above the threshold. The threshold lies between low speed or idling and high speed or acceleration.

Since Claims 1 and 2 add to the teachings of D1 to D3 merely a definition of the idling state by the conditions I to IV and since this definition is obvious for the person skilled in the art, the subject-matter of Claims 1 and 2 lacks inventive step.

V. Following a communication from the Board the Appellant submitted amended patent documents with the letter of 16 February 1995. The Respondent made no comment on either the Board's communication or the Appellant's reply.

The independent Claim 1 is as follows:

"An electrical fuel injection device comprising
- an injection valve (3) for injecting fuel into an internal combustion engine (10);
- an air flow meter (9) for detecting an amount of intake air fed to said internal combustion engine (10) through a throttle valve (2);
- a revolution counter (20) for measuring the rotational speed of said internal combustion engine (10);
- an electronic circuit (15) for determining an opening and closing time of said injection valve (3) based on output signals from said air flow meter (9) and said revolution counter (20); and
- digital filter means (31, 32) in said electronic circuit (15), having variable filter coefficients, characterized in that there is provided a first digital filter (31, 32) which attenuates an input signal with a first coefficient (X_1) when said engine is in an idling state, wherein the following conditions are met:

I. the opening degree of said throttle valve is smaller than a predetermined opening degree (e.g. 1°);

II. the revolution count is less than a predetermined rotational speed N (e.g. 1500/min);

III. the valve opening pulse width of the injection valve is shorter than a predetermined pulse width T_p (e.g. 1,7 ms);

IV. the air intake amount is less than a predetermined amount Q_a (e.g. 125 g/min);

and attenuates the input signal with a second coefficient (X_2) larger than said first coefficient (X_1) when said engine is in a normal drive state, wherein one or a plurality of following conditions is met:

V. the opening degree of said throttle valve is larger than said predetermined opening degree;

VI. the revolution count is more than said predetermined rotational speed N;

VII. the valve opening pulse width of the injection valve is longer than said predetermined pulse width T_p;

VIII. the air intake amount is more than said predetermined amount Q_a;

and the output signal from said airflow meter (9) is applied to said electronic circuit as the input signal through said first digital filter, whereby said digital filter has a larger attenuation effect with said first coefficient than with said second coefficient."

The independent Claim 2 is as follows:

"An electrical fuel injector device comprising
- an injection valve (3) for injecting fuel into an internal combustion engine (10);
- an air flow meter (9) for detecting an amount of intake air fed to said internal combustion engine (10) through a throttle valve (2);
- a revolution counter (20) for measuring the rotational speed of said internal combustion engine (10);
- an electronic circuit (15) for determining an opening and a closing time of said injection valve (3) based on output signals from said air flow meter (9) and said revolution counter (20); and
- digital filter means (31, 32) in said electronic circuit (15), having variable filter coefficients,

characterized in that there is provided a first digital filter (31, 32) which attenuates an input signal with a first coefficient (X_1) when said engine is in an idling state, wherein the following conditions are met:

I. the opening degree of said throttle valve is smaller than a predetermined opening degree (e.g. 1°);

II. the revolution count is less than a predetermined rotational speed N (e.g. 1500/min);

III. the valve opening pulse width of the injection valve is shorter than a predetermined pulse width T_p (e.g. 1,7 ms);

IV. the air intake amount is less than a predetermined amount Q_a (e.g. 125 g/min);

and attenuates the input signal with a second coefficient (X_2) larger than said first coefficient (X_1) when said engine is in a normal drive state, wherein one or a plurality of following conditions is met:

V. the opening degree of said throttle valve is larger than said predetermined opening degree;

VI. the revolution count is more than said predetermined rotational speed N;

VII. the valve opening pulse width of the injection valve is longer than said predetermined pulse width T_p;

VIII. the air intake amount is more than said predetermined amount Q_a;

and the output signal from said revolution counter (20) is applied to said electronic circuit as the input signal through said first digital filter, whereby said digital filter has a larger attenuation effect with said first coefficient than with said second coefficient."

VI. The Appellant requests that the decision under appeal be set aside and that the patent be maintained amended in the following form:

Claim 1: page 5, lines 62 to 65 of the patent specification as granted (EP-B1-0 087 809), and

page 6, lines 1 to 22 as filed with the letter of 16 February 1995;

Claims 2 to 4: as filed with the letter of 16 February 1995;

Description: pages 2 and 2a as filed with the letter of 16 February 1995,

page 3, line 1 to page 5, line 58 of the patent specification as granted (EP-B1-0 087 809); and

Drawings: pages 1 to 6 of the patent specification as granted (EP-B1-0 087 809).

The Appellant auxiliarily requests oral proceedings.

VI. The Respondent requests dismissal of the appeal.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 The words "wherein one or a plurality of the following conditions is met" in Claims 1 and 2 as granted (lines 6, 7 and 32, 33 respectively of page 6 of the patent specification as granted) have been amended to "wherein the following conditions are met" to arrive at the present Claims 1 and 2.

These amendments do not contravene Article 123(2) EPC in view of page 8, lines 1 to 15 of the application as originally filed and do not contravene Article 123(3) EPC because they restrict the scope of the claims.

2.2 Claims 3 and 4 filed with the letter of 16 February 1995 are identical to Claims 3 and 4 as granted.

2.3 The present description is identical to that in the patent specification as granted except that the discussion of D1 on page 2 has been amended. In view of the explanation given by the Appellant in the letter of 16 February 1995 the Board considers that the original discussion in the description as granted was incorrect (see section 7.1 below) and has no objection under Article 123 EPC to the reworded page 2a filed with said letter.

2.4 Thus the Board has no objection under Article 123 EPC to the present version of the patent documents.

3. *The term "idling state"*

The wording of Claims 1 and 2 as granted led to doubt as to what was meant by the term "idling state". This doubt has been removed in the present versions of Claims 1 and 2. For the engine to be deemed to be in the idling state the (i.e. all of) the four conditions I to IV must be fulfilled. It follows from this that the four other conditions V to VIII when the engine is **not** idling are

correctly preceded in said Claims by the words "wherein one or a plurality of following conditions is met" since it needs only one of these conditions V to VIII to be met (e.g. a wide open throttle) for the skilled person to know that the engine cannot be idling.

4. *Novelty*

After considering the documents present in the appeal proceedings the Board considers that none of them discloses an electrical fuel injection device according to either Claim 1 or Claim 2. Novelty was moreover not disputed in the appeal proceedings by the parties.

5. *The closest prior art*

5.1 Like the parties and the Opposition Division, the Board considers that the closest prior art is represented by D1 since it discloses the features of the pre-characterising portion of each of Claims 1 and 2.

5.2 According to the characterising portion of Claim 1 the claimed device differs from the state of the art in that the digital filter attenuates the engine intake air amount signal with a first coefficient when the engine is idling (as defined by conditions I to IV) and with a second filter coefficient when the engine is in a normal driving state, the first coefficient providing a larger attenuation effect than the second.

Claim 2 differs from Claim 1 in that it is the engine speed signal instead of the engine intake air amount signal which is filtered.

6. *Problem and solution*

6.1 In the letter of 16 February 1995 the Appellant formulates the problem to be solved in such a way as to fix the attention on the idling and non-idling states and so impermissibly to point to the solution (see decision T 229/85, OJ EPO 1987, 237).

The Board in fact sees the problem to be solved when starting from the apparatus according to D1 as being to provide an electrical fuel injection device which can improve engine control under each operating condition including idling and driving conditions.

6.3 The Board is satisfied that this problem can be solved by the features of the present Claims 1 and 2, and in particular by the features of their characterising portions.

7. *Inventive step*

7.1 D1 explains in column 1, lines 40 to 48 that it is known to control how much fuel is injected into an internal combustion engine by opening a fuel injection valve for a time which is dependent on the amount of air entering the engine and the rotational speed of the engine. However (continues D1 in column 1, line 61 to column 2, line 5), the signal representing the intake air flow rate contains ripple due to the engine's intermittent sucking of air, moreover the signal representing the engine's rotational speed contains ripple due to the engine's unevenness of rotation.

These ripples render optimal engine control impossible, and D1 proposes (see column 26, line 18 to column 27, line 26) to eliminate the ripple component of the signal representing the rotational speed of the engine.

Therefore in D1 the problem to be solved appears to be different from that according to the invention.

The solution proposed in D1 consists of filtering the signal by using the present sampled value of the rotation speed parameter (obtained in the present calculation cycle), the previous filtered value of the parameter (arrived at in the immediately preceding calculation cycle) and a filter coefficient α between zero and one, in order to arrive at the present filtered value of the rotational speed of the engine. One of several different filter coefficients α stored in a read only memory (see Figure 20) can be used but it is not stated when and why different filter coefficients should be used.

While different filter coefficients are disclosed in D1, see e.g. Figure 20, the Board indeed cannot find a disclosure of the use of different filter coefficients for one particular signal.

Since moreover the Appellant now argues (in section 2 of the letter of 16 February 1995) that the acknowledgement of D1 in the granted patent specification (see page 2, lines 22 to 24) is incorrect and that in fact a (single) predetermined filter coefficient is used for a particular input signal, and since the Respondent has not contradicted said allegation, the Board can accept that D1 teaches no more than the choice of a filter coefficient once and for all for a particular signal in a particular engine.

Therefore the Board considers that variable filter constants for a particular signal are not known from D1 and that, contrary to the Opposition Division's opinion, the contribution by the skilled person to the teaching of D1 is not merely that of deciding how to set the variable filter constants to match the driving conditions.

Moreover, even if two filter coefficients for a particular signal were known from D1, the document gives the skilled person no reason to view idling and non-idling as being important for signal filtering because even when D1 mentions idling in column 3, lines 53 to 68 this is not in connection with filtering signals but purely in the context of adjustment of air flow around the throttle valve through a bypass 42 (Figure 1 and column 3, lines 63 to 68) or through the bypass air regulator 48 (Figure 1 and column 4, lines 1 to 11) to achieve a preset fixed value of idle speed by a feedback control (column 25, lines 30 to 35).

7.2 Also D2 discusses a problem which is different from that to be solved by the invention. The aim of D2 is to prevent the periodic vibratory back-and-forth motion resulting from a resonance between the change in the output torque of an engine and the mechanical structure of the engine (see column 1, lines 30 to 44) when the engine is decelerated with the throttle valve being closed or accelerated from a low rotation speed.

Moreover the solution given in D2 has nothing to do with the invention since, in order to prevent this vehicle surge, a value of engine rotation speed below which the potential of a vehicle surge is high is determined experimentally (see column 4, lines 21 to 53) and if the engine rotation speed is below the predetermined value, indicating a high surge potential, then the value of

engine rotation speed used to calculate the amount of fuel to be injected is a value based on the current engine rotation speed, the calculated engine rotation speed from the previous calculating step and a constant K, see step 107 on Figure 2.

In a second embodiment (see column 6, line 47 to column 7, line 15), the calculation uses a constant K (see step 107 on Figure 3) whose value is large or small (see steps 115 and 116 on Figure 3) dependent on whether the change in intake air amount and the change in engine rotation speed between the current and preceding calculation cycles are above or below predetermined values (see steps 113 and 114 on Figure 3).

7.3 The problem described in D3 is also different from that of the patent since D3 deals with transitional enrichment of the fuel/air mixture, particularly during the warming-up phase of the engine, in order that the engine can be accelerated with sufficient rapidity, see page 2, lines 21 to 31. Fluctuations in the air inlet manifold during specific operating conditions cause fluctuations in the signal representing the intake air flow amount which can be largely suppressed with a low-pass filter which however has a poor transition characteristic during acceleration since its damping and time constant are too great, see page 2, lines 67 to 88. This disadvantage can be overcome by e.g. by switching the frequency-determining capacitors of the low-pass filter dependent on acceleration or quantity of air (see page 4, lines 89 to 106).

7.4 The choice of filter coefficients in D2 and D3 results in a larger attenuation effect being achieved in lower load states than in higher load states. Moreover these

lower and higher load states can be characterised by rotation speed values above or below a predetermined limit (D2) or air flow values above or below a predetermined limit (D3).

The Opposition Division's finding on page 9 of its decision that the subject-matter of Claims 1 and 2 resulted from a combination of D1 and D2 or D2 and D3 respectively referred to the claims in their granted form with an imperfect definition of the idling state. Now that the claims have been clarified in this respect it follows that while low load and idling states overlap, they are not the same i.e. they are not co-extensive. Thus D2 and D3 do not teach the skilled person that the criterion for switching filter constants should be the presence or absence of idling. D2 and D3 teach other criteria for switching filter constants and do not concern idling problems but **vehicle** surge due to resonance between engine output torque and the vehicle mechanical structure (D2) and transitional enrichment of the fuel/air mixture, particularly during the warming-up phase of the engine, in order that the engine can be accelerated with sufficient rapidity (D3).

7.5 Accordingly the Board finds that the skilled person would not have been led to combine the teachings of documents D1 and D2 or of D1 and D3. Even if he had done so, he would not have arrived at the subject-matter of either of Claims 1 or Claim 2 in an obvious manner.

8. Thus the subject-matter of each of the independent Claims 1 and 2 involves an inventive step in the meaning of Article 56 EPC and is patentable in the meaning of Article 52 EPC. Claims 3 and 4 are dependent on Claim 1 and so are also patentable. The patent can thus be maintained with these claims.

9. *The description*

The description needs some amendment to adapt it to the new independent Claims 1 and 2, e.g. concerning the words "wherein one **or a plurality of** the following conditions **is** met" in line 44 of page 2 filed with the letter of 16 February 1995 and in line 5 of page 3 of the granted patent specification, and concerning page 4, lines 28 to 31.

In order to avoid prolonging the appeal proceedings, the case is remitted to the first instance to have these amendments to the description carried out before maintaining the patent.

The granted patent specification contains also some minor errors but since they would cause no problems to the person skilled in the art, the Board has no objections to these. It sees extensive minor improvements as being unnecessary and undesirable in both opposition and appeal proceedings since the latter are not designed to be, and should not be misused as, extensions of examination procedure (see point 9 of decision G 1/84, OJ EPO 1985, 304).

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 form:

Claim 1: page 5, lines 62 to 65 of the patent specification as granted (EP-B1-0 087 809), and
page 6, lines 1 to 22 as filed with the letter of 16 February 1995;

Claims 2 to 4: as filed with the letter of 16 February 1995;

Description: page 2 as filed with the letter of 16 February 1995, to be adapted in line with the Claims;
page 2a as filed with the letter of 16 February 1995;
pages 3 and 4 of the patent specification as granted (EP-B1-0 087 809), to be adapted in line with the Claims;
page 5, lines 1 to 58 of the patent specification as granted (EP-B1-0 087 809); and

Drawings: pages 1 to 6 of the patent specification as granted (EP-B1-0 087 809).

The Registrar: The Chairman:

N. Maslin R. Gryc