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File Number: T 318/91 - 3.5.1  
Application No.: 82 304 034.0  
Publication No.: 0 072 162  
Title of invention: Method and system for controlling ignition timing in a  
multicylinder internal combustion engine

Classification: F02P 5/04

**D E C I S I O N**  
of 18 August 1992

Proprietor of the patent: NIPPONDENSO CO., LTD.

Opponent: 01) Robert Bosch GmbH  
02) Siemens AG

Headword:

EPC Articles 56 and 104

Keyword: "Inventive step (yes)"  
"Apportionment of costs (no)"  
"Late-filed documents (not allowed - not relevant)"



Case Number : T 318/91 - 3.5.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.5.1  
of 18 August 1992

**Appellant :** Robert Bosch GmbH  
(Opponent 01) Postfach 10 60 50  
W - 7000 Stuttgart 10 (DE)

**Appellant :** Siemens Aktiengesellschaft  
(Opponent 02) Berlin und München  
Postfach 22 16 34  
W - 8000 München 22 (DE)

**Respondent :** NIPPONDENSO CO., LTD.  
(Proprietor of the patent) 1-1, Showa-cho  
Kariya-shi  
Aichi-ken (JP)

**Representative :** Milhench, Howard Leslie  
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**Decision under appeal :** Interlocutory decision of the Opposition Division  
of the European Patent Office dated 1 March 1991  
concerning maintenance of European patent  
No. 0 072 162 in amended form.

**Composition of the Board :**

**Chairman :** P.K.J. van den Berg  
**Members :** R. Randes  
G. Davies

Summary of Facts and Submissions

- I. European patent No. 0 072 162 was granted on 29 January 1986 on the basis of European patent application No. 82 304 034.0, filed on 30 July 1982.
- II. A first opposition was filed on 27 October 1986 by Robert Bosch GmbH, a second on 29 October 1986 by Siemens AG. Both Opponents attacked the inventive step of Claims 1 and 7.

The Opponents cited several documents, of which the most important were:

D1: US-A-4 116 173

D2: DE-A-29 41 977, and

D4: "Kleine Enzyklopädie Mathematik", Thun, 1977.

- III. By an interlocutory decision (Article 106(3) EPC) given at oral proceedings on 3 October 1990 and notified to the parties in writing on 1 March 1991, the Opposition Division expressed its view that the patent as amended during the opposition proceedings met the requirements of the EPC. The Division arrived at this conclusion after having refused under Article 114(2) EPC to take into account the document

D3: "Optimum Seeking Methods", Englewood Cliffs, 1964

which had been filed by Siemens only two days before the oral proceedings took place.

- IV. Claim 1 as maintained reads:

"A method, in a multicylinder internal combustion engine, for obtaining an optimum combination of ignition timings

for individual cylinders of the engine, comprising the steps of:

- (a) detecting at least one engine running condition parameter
- (b) selecting a group of  $(M+1)$  combinations of ignition timings where  $M$  is the number of engine cylinders, each combination comprising ignition timings for the individual cylinders of the engine, which timings are determined in accordance with the running condition parameter;
- (c) successively operating the engine according to each combination of ignition timings in the group for a predetermined period;
- (d) detecting, in each period, a parameter value corresponding to the engine output characteristic;
- (e) determining, by comparing the detected parameter values obtained for each of the combinations in said group, the combination of ignition timings  $\theta_{\min}$  producing an engine output characteristic most distant from the optimum output characteristic;
- (f) calculating a new combination of ignition timings  $\theta_{\text{new}}$  by using a predetermined formula which defines  $\theta_{\text{new}}$  for each cylinder in terms of  $\theta_{\min}$  for that cylinder and the average value  $\theta_{\text{av}}$  of the ignition timings for that cylinder in the group of combinations of ignition timings such that operation of the engine in accordance with the calculated values of  $\theta_{\text{new}}$  for the respective cylinders may be expected to produce a parameter value corresponding to an engine output characteristic which is closer to the optimum output characteristic than would be obtained by operation of the engine according to the average ignition timings  $\theta_{\text{av}}$ ;
- (g) operating the engine at the new combination of ignition-timings for the predetermined period;
- (h) detecting the engine output characteristic parameter value obtained in the operation in step (g);

(i) substituting, in said group of combinations of ignition timings in (b), the new combination of ignition timings  $\theta_{\text{new}}$  for the combination of ignition timings  $\theta_{\text{min}}$ ; and

(j) repeating the above-mentioned steps (e) through (i) so that the combination of ignition timings obtained in step (f) progressively approaches the combination of ignition timings corresponding to optimum operation of the engine."

V. Claim 7 as maintained reads:

"A system for controlling ignition timing of a multicylinder internal combustion engine provided with a spark device for each cylinder, adapted for obtaining an optimum combination of ignition timings for individual cylinders of the engine producing an optimum engine output characteristic, comprising:

(a) driving means connected to the spark devices of the engine cylinders for independently controlling the operation when the cylinders are ignited;

(b) first sensing means for providing electric signals indicating at least one engine running condition;

(c) second sensing means for providing electric signals indicating the engine output characteristic;

(d) operating means responsive to the signals from the sensing means to provide signals directed to the driving means for controlling the ignition timings of the cylinders, said operating means comprising:

(i) means for receiving signals from the first sensing means, indicating at least one engine running condition parameter;

(ii) means for selecting a group of  $(M+1)$  combinations of ignition timings where  $M$  is the number of engine cylinders, each combination comprising ignition timings for the individual cylinders of the engine, which timings

are determined in accordance with the running condition parameter;

(iii) means for producing signals directed to said drive means for successively operating the engine according to each combination of ignition timings in the group for a predetermined period;

(iv) means for receiving signals from the second sensing means for detecting, in each period, a parameter value corresponding to the engine output characteristic;

(v) means for determining, by comparing the detected parameter values obtained for each of the combinations in said group, the combination of ignition timings  $\theta_{\min}$  producing an engine output characteristic most distant from the optimum output characteristic;

(vi) means for calculating a new combination of ignition timings  $\theta_{\text{new}}$  by using a predetermined formula which defines  $\theta_{\text{new}}$  for each cylinder in terms of  $\theta_{\min}$  for that cylinder and the average value  $\theta_{\text{av}}$  of the ignition timings for that cylinder in the group of combinations of ignition timings such that operation of the engine in accordance with the calculated values of  $\theta_{\text{new}}$  for the respective cylinders may be expected to produce a parameter value corresponding to an engine output characteristic which is closer to the optimum output characteristic than would be obtained by operation of the engine according to a combination of ignition timings corresponding to the average ignition timings  $\theta_{\text{av}}$ ;

(vii) means for producing signals directed to said drive means for operating the engine at the new combination of ignition timings for the predetermined period;

(viii) means for receiving signals from the second sensing means for detecting the engine output condition parameter value obtained in the operation of the means (vii);

(ix) means for substituting, in said group of combinations of ignition timings in (ii), the new combination of

ignition timings  $\theta_{new}$  for the combination of ignition timings  $\theta_{min}$ ; and

(x) means for repeating the steps effected by the means recited in (v) through (ix) so that the combination of ignition values obtained by the means (vi) progressively approaches the combination of ignition timings corresponding to optimum operation of the engine."

- VI. Both opponents lodged an appeal against this decision, Bosch (Appellant I) on 19 April 1991 and Siemens (Appellant II) on 2 May 1991. In the Grounds of Appeal, which was filed together with the Notice of Appeal, Appellant I referred to the late filed document D3, as did Appellant II in his Grounds of Appeal filed on 10 June 1991.
- VII. In a communication of the Board - pursuant to Article 11(2) of the Rules of procedure of the Boards of Appeal - dated 2 April 1992 the Rapporteur expressed the preliminary view that the impugned decision was correct.
- VIII. Oral proceedings were held on 18 August 1992. Appellant II did not attend, as he had already announced in a letter received on 1 July.
- IX. The arguments of the Appellants can be summarised as follows.

Both Appellants start out from the Opposition Division's finding that, having regard to the prior art, it was "obvious to persons skilled in the art to control the cylinders of an internal combustion engine individually so as to obtain that ignition timing in each cylinder which will produce optimum performance of the engine". In arriving at this conclusion the Opposition Division had considered D1 and D2 as prior art. Appellant II was even

of the opinion that the teaching of D1 alone was sufficient to enable a skilled man to arrive at said principle; Appellant I argued that it was obvious from D2 which described that two cylinders out of four were used for testing different ignition timings and that the engine torque was measured for that cylinder pair separately to decide whether the change in timing brought about an improvement or not. Both Appellants considered the characterising steps (b) to (j) of Claim 1 (and the corresponding characterising features of Claim 7) as obvious in the light of the teaching of D4 and D3. They furthermore demanded that D3, which had been disregarded by the Opposition Division, be allowed into the proceedings. D3 was said to be more relevant than D4 in that it disclosed a method involving M+1 combinations of ignition timings, corresponding to the invention. The Appellants admitted that the mathematical methods according to D4 and D3 were not identical to the one used by the invention but nevertheless held that the method according to the invention represented nothing but simple measures which could be derived from these documents and modified in order to fit the special application, thus being within the capabilities of the skilled man.

- X. The Respondent's arguments in support of the patentability of the subject-matter of Claims 1 and 7 may be summarised as follows.

The invention concerned an optimisation method involving the measurement of an engine characteristic, such as the speed, for different combinations of cylinder ignition timings. For a motor having M cylinders the method used a set of M+1 combinations, of which the one yielding the lowest output was dropped and replaced by new timing values computed on the basis of the dropped combination



and an average of all M+1 combinations. No prior art document disclosed a similar method:

D1, although concerned with the individual control of the different cylinders, did not disclose or prove that this control - which involved the detection of undesirable detonations - resulted in an optimum torque for the whole engine even if this could be true for a single cylinder;

D2 did not disclose an individual control of all cylinders and no calculation of new values;

D3 described a mathematical method of optimisation - not in connection with combustion engines - also involving a set of combinations from which new combinations were successively computed to arrive at an optimum; however, a new combination was only computed if changes in each of the variables had proved not to result in a better result. Moreover, the new combination was in fact not a function of M+1 values, but of M (for each variable the point yielding the highest output with the other variables kept constant), and the computation did not involve the determination of a previous combination yielding the least good result;

D4 was even further away since the method particularly indicated by the Appellants (the "gradient method", page 696) presupposed knowledge of the mathematical expression for the function to be optimised.

- XI. The Appellants requested that the decision under appeal be set aside and that the patent be revoked.
  
- XII. The Respondent requested that the appeals be dismissed and that the patent be maintained as maintained by the Opposition Division (main request).

Alternatively, he requested maintenance of the patent on the basis of Claim 1 combined with Claim 2 and Claim 7 combined with Claim 10 as independent claims (auxiliary request).

He also requested an award of costs against the Appellants (Article 104(1) EPC).

**Reasons for the Decision**

1. The appeals are admissible.

Allowability of the amendments

2. Neither of the Appellants raised an objection under Article 123(2), (3) EPC, nor is it apparent to the Board that such an objection would be justified.

Inventive step

3. Since novelty is not at issue, the Board will turn directly to the question of inventive step.

Main request

4. The invention as defined in the method Claim 1 and system Claim 7 consists in optimising the performance of a multi-cylinder internal combustion engine by adjusting the ignition timing of each cylinder individually, using a particular iterative method of optimisation.
5. According to the prior art acknowledged in the patent, page 2, multi-cylinder motors have previously been adjusted for all cylinders collectively so that individual

characteristics of cylinders could not be accounted for, leading to non-optimum performance of the engine. Having regard to this prior art, the present invention can be seen as the solution to two interlinked problem-solution processes. The "general" problem is to optimise the engine power by adjusting the ignition timing in a new way. According to the invention, the solution to this general problem is the idea of adjusting the cylinders individually. Only after this idea has been conceived, can the "detailed" problem be formulated, namely to find an effective method (and corresponding system) according to which the individual cylinders can be adjusted in order to optimise the performance of the engine.

6. The Appellants argued that the "general" problem had already been recognised and solved in literature. In this respect they referred to D1 and D2, both separately and in combination. The Opposition Division also adopted this view (point 3.6 of the decision). The Board, however, sees no need to settle this question definitively since, even if this measure was indeed obvious, the solution of the "detailed" problem would not have been obvious. The reasons for this view are set out below.
  
7. The outstanding features of Claims 1 and 7 are that the optimum ignition timing of each of the M cylinders of the engine is found by creating a set of M+1 timing combinations (where each combination consists of M values), measuring an engine characteristic such as the engine speed for each combination, selecting the combination  $\theta_{\min}$  yielding the least good output and finding a new combination as a function of that particular combination and the average  $\theta_{\text{av}}$  of the set of M+1 combinations. The new value takes the place of  $\theta_{\min}$ . The computation of new values is repeated until the optimum output has been obtained. Thus according to the invention,

at each step of the optimisation process only one experimental determination of the engine characteristic is necessary.

8. In the view of the Board, these features are not suggested by the prior art documents D1 to D4, either separately or in combination.

8.1 ~~As to D1, the Board agrees with the considerations put forward by the Respondent during the oral proceedings (cf. point X above). The document does not suggest the claimed method.~~

8.2 D2, in connection with Figure 4, describes a method for simultaneously optimising the ignition timing and the fuel injection. The effect on the motor is in both cases measured by means of the motor torque. To distinguish between the impacts of each variable on the torque, the optimisation works by test excursions from the original variable values for separate cylinder pairs. Thus cylinders 1 and 3 are used for optimising the ignition timing and cylinders 2 and 4 for optimising the fuel injection.

Even if the described method may be regarded as involving the optimisation of a single entity (the torque) as a function of more than one variable (ignition timing, fuel injection) there is apparently no detection of the combined effect of changes in both variables since the torque is detected separately for different groups of cylinders. Instead, each variable is treated separately until its optimum value is found. This should be contrasted with the present invention according to which a new variable value depends on the values of all the other variables (except for the initial combinations).

8.3 D3, which was filed after the expiry of the opposition period, is in the Board's view not so relevant as to raise real doubts as to the inventive step of the claimed subject-matter (cf. point X above). It is also noted that at no time have the Appellants attempted seriously to identify the individual characterising features of Claims 1 and 7 with the features of the methods described in D3. The document is therefore not admitted into the procedure (Article 114(2) EPC).

8.4 D4 discloses a number of optimisation methods, of which the Appellants have in particular referred to the gradient method described on page 696. According to this method, an iterative search process is based on the gradient (indicating the steepest slope) of a mathematical function. The gradient is computed by differentiation of the mathematical expression of the function. The Board cannot see that this method is of much use when, as in the present case, a mathematical expression is not known. Although D4 mentions the possibility of finding extreme points without knowledge of such an expression (page 692), the gradient method apparently does not have this advantage.

Moreover, the Appellants themselves regarded D4 as less relevant than D3. Thus the teaching of D4 can in no way give the skilled man the idea of using the particular method steps proposed in Claim 1.

9. The Appellants have argued furthermore that the skilled man would, as a matter of course and starting from methods found in mathematical handbooks, in a particular case find a suitable algorithm without exercising technical skill. The Board cannot concur with this view. The skilled man, when faced with a technical problem involving optimisation, may be expected to look up a handbook and

choose an algorithm when having an indication that such an algorithm would suit his needs in that particular technical field; but he would in no way be able to devise a new algorithm, i.e. effectively to add to the handbook, without exercising particular skill.

In the Board's view, the method according to the patent in suit is distinguished from the prior art in particular in the determination of the combination of timings yielding the least good result and the combination representing the average of all M+1 combinations in order to compute a single new combination of ignition timing values replacing the combination yielding the least good result.

10. To summarise, the Board has concluded that, even if it would have been obvious from D1 and/or D2 to individually control the cylinders of a multi-cylinder internal combustion engine, it would not have been obvious to do it in the way set out in the independent claims (Article 56 EPC). Thus the patent can be maintained in the form decided on by the Opposition Division during oral proceedings.

#### Auxiliary request

11. The Respondent's main request being accepted, there is no need to consider the auxiliary request.

#### Costs

12. The Respondent requested that an award of costs incurred in proceedings before the Board of Appeal be made in its favour against the Appellants on the ground that the Appellants had pursued the case on appeal "in defiance of accepted practice and reason" on the basis of arguments unlikely to succeed.

Article 104 EPC lays down the general principle with regard to costs that each party to the proceedings shall meet the costs he has incurred unless a decision of an Opposition Division or a Board of Appeal, for reasons of equity, orders a different apportionment of costs incurred during taking of evidence or in oral proceedings.

An award of costs in oral proceedings is rarely made. Such awards have been made in cases where, in the absence of strong mitigating circumstances, a party has been guilty of late filing of facts and evidence in the appeal proceedings (see e.g. Decisions T 326/87, OJ EPO 1991, 9 and T 611/90, OJ EPO 1992, 3). However, in Decision T 383/87 (of 26 April 1989, unpublished), the Board of Appeal, refusing an award of costs, stated that consideration of the quality of the appeal "could never be a reason for ordering a different apportionment of costs ... This is because Article 116(1) EPC guarantees the right of any party to request oral proceedings i.e. to argue his case orally before the relevant instance of the EPO. It may be that a party feels he can present his arguments better orally than in writing, even if he has no new arguments". The Board emphasised that the basic right to request oral proceedings could only be refused in exceptional circumstances if the request amounted to a clear abuse of the law.

In the present case, the Appellants did not seek to introduce into the appeal proceedings late-filed facts or evidence; they merely tried to convince the Board of the relevance of the cited reference D3, which had been disregarded by the Opposition Division as it had been filed late in the opposition proceedings and was not considered relevant. The Appellants had the right both to pursue the case on appeal and to request oral proceedings. The question of their chances of winning the case is irrelevant. The Board, therefore, considers that in this

case there are no exceptional circumstances amounting to a clear abuse of law. The request of the Respondent for an award of costs against the Appellants is refused.

Order

For these reasons, it is decided that:


1. The appeals are dismissed.
2. No apportionment of costs is to be made.

The Registrar:



M. Kiehl

The Chairman:



P.K.J. van den Berg

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