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**D E C I S I O N**  
of 16 December 2005

**Case Number:** T 0383/04 - 3.2.04

**Application Number:** 94920655.1

**Publication Number:** 0793772

**IPC:** F02B 67/08

**Language of the proceedings:** EN

**Title of invention:**

Method and apparatus for operation of engines

**Applicant:**

McAlister, Roy E.

**Opponent:**

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**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56, 84

**Keyword:**

"Inventive step - no"

"Unexpected advantages do not render obvious solution  
inventive"

**Decisions cited:**

T 0936/96, T 0032/82

**Catchword:**

-



Case Number: T 0383/04 - 3.2.04

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.04  
of 16 December 2005

**Appellant:**

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**Representative:**

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**Decision under appeal:**

Decision of the Examining Division of the  
European Patent Office posted 21 October 2003  
refusing European application No. 94920655.1  
pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** M. Ceyte  
**Members:** M. Poock  
T. Bokor

## Summary of Facts and Submissions

I. This appeal is directed against the decision of the examining division dated 21 October 2003 in which European patent application No. 94 920 655.1 was refused.

The appellant (applicant) lodged the appeal on 31 December 2003 and paid the prescribed appeal fee simultaneously. The statement of grounds of appeal was received on 27 February 2004.

II. The following documents are relevant for this decision:

- D1: US-A-3 830 204;
- D2: US-A-4 448 160;
- D3: US-A-3 236 219;
- D4: GB-A-2 145 153;
- D5: DE-A-3 130 238;
- D6: "Abgastechnik für Ottomotoren", Bosch handbook, 1985, pages 10 and 11;
- Annex A: "SHED TESTS WITH ADAPTIVE SPARKINJECTORS", comparative tests of the appellant;
- Annex B: Declaration by Robert Priest, a technical expert in this field.

III. The examining division held inter alia that the subject-matter of claim 1 does not involve an inventive step having regard to the spark ignited combustion engines known from D1 to D3 in combination with the injectors having built-in sensors known from D4 or D5.

- IV. Oral proceedings before the board were held on 16 December 2005.

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 6 filed with the grounds of appeal (main request), or claims 1 to 6 filed with the fax on 30 November 2005 (auxiliary request), and that the case be remitted to the examining division for the adaptation of the description.

- V. Claim 1 of the main request reads as follows:

"1. A combustion engine having at least one combustion chamber provided with a fuel injector for directly injecting fuel selected from liquid hydrocarbons and gaseous fuels including methane and/or hydrogen into said chamber, characterised in that (i) said injector incorporates means for effecting spark ignition of said fuel substantially at the location of its injection into said chamber and means for sensing information relating to one or more of intake, compression, fuel pressure, fuel flow period, ignition, combustion, expansion and exhaust, and (ii) said engine incorporates an adaptive controller for adjusting operation of the engine in response to the sensed information in order to optimise one or more of thermal efficiency, power production, engine smoothness, combustion temperature control and minimisation of formation of oxides of nitrogen."

Claims 1 of the main and auxiliary requests are distinguished only in the following:

"A combustion engine having at least one combustion chamber provided with a fuel injector for directly injecting gaseous hydrogen fuel into said chamber, characterised in that ...".

VI. The appellant's arguments may be summarized as follows:

The term "adaptive controller" used in claim 1 would imply to employ a map for adjusting the sensed value of an engine parameter to a desired value.

The combination of a spark injector, a sensing means and an adaptive controller as defined in claim 1 gives rise to substantial and unexpected advantages which, as such, imply the presence of inventive step. Adaptive spark injection permits rapid and inexpensive conversion of conventional internal combustion engines to operate on hydrogen whilst almost completely eliminating emissions of nitrogen oxides.

For adaptive spark injection engines, annex A demonstrates that the content of hydrocarbons in the exhaust gas is reduced when the engine runs on hydrogen so that the air is effectively cleaned, that the engines could be started directly through spark ignition without a starter motor, that the combustion is highly efficient in very lean mixtures, and that adaptive control ensures total avoidance of knock in contrast to existing engine control systems which react to minimise knock after it has been detected. In support of these submissions, the appellant also referred to Annex B.

Further he argued on the board's argument that a claim has to include all essential technical features, that it is not necessary to specify in claim 1 how the adaptive controller is adjusted for achieving the stated advantages.

## **Reasons for the Decision**

1. The appeal complies with the requirements of Articles 106 to 108 and Rule 64 EPC. Therefore, it is admissible.
2. *Inventive step*
  - 2.1 Claim 1 of the main request requires that the fuel injector is suitable for injecting fuel selected from liquid hydrocarbons and gaseous fuels including methane and/or hydrogen. In contrast, the selected fuel, according to claim 1 of the auxiliary request, is only gaseous hydrogen fuel.

Thus, if the auxiliary request cannot be allowed because the subject-matter of its claim 1 lacks an inventive step, then the main request cannot be allowed either. For this reason, claim 1 of the auxiliary request will be considered first.

- 2.2 Closest prior art

D1 and D2 relate generally to internal combustion engines and more particularly to combined fuel injectors and igniters. They disclose a combustion engine having at least one combustion chamber provided

with a fuel injector (see figures 1 of D1 and D2) for directly injecting gaseous hydrogen fuel into said chamber (D1: column 11, lines 24 to 26 in combination with column 2, lines 3 to 8; D2: column 5, lines 26 to 30).

The injectors incorporate means for effecting spark ignition of said fuel substantially at the location of its injection into said chamber (see Figures 1 of D1 and D2).

The board therefore agrees with the appellant that the combustion engines of D1 or D2 could be considered to represent the closest prior art.

## 2.3 Problem and solution

### 2.3.1 Alternative embodiments in claim 1

The subject-matter of claim 1 is distinguished from the combustion engines of D1 or D2 in that the injector incorporates means for sensing information relating to one or more of intake, compression, fuel pressure, fuel flow period, ignition, combustion, expansion and exhaust, and in that the engine incorporates an adaptive controller for adjusting operation of the engine in response to the sensed information in order to optimise one or more of thermal efficiency, power production, engine smoothness, combustion temperature control and minimisation of formation of oxides of nitrogen.

Thus, depending on the type of sensor or adaptive controller, several alternative embodiments are claimed

which are defined by the kind of information the means for sensing is adapted for and the optimised parameter the adaptive controller is adapted for.

For a patent to be granted it is necessary that all alternative embodiments embraced by the claim meet the requirements of the EPC, in particular that they involve an inventive step. If only one alternative embodiment fails to meet these requirements, the request to grant a patent cannot be allowed.

- 2.3.2 As stated in the application as filed on page 4, paragraph 8 from the bottom, the problem to be solved may be seen in the provision of a combustion engine with optimised thermal efficiency and power production.

On the basis of the information given in the application, the solution to this problem includes means for sensing information relating to the compression, combustion, ignition and/or exhaust and an adaptive controller for adjusting operation of the engine in response to the sensed information in order to optimise the thermal efficiency and/or the power production.

#### 2.4 Obviousness of this solution

- 2.4.1 If the person skilled in the art tries to find a solution to this technical problem, it can be expected that he would consider documents D4 and D5, because they relate to the same technical field, i.e. fuel injected combustion engines.



These engines are provided with pressure sensitive sensors (D4: page 1, lines 23 to 32; D5: figure 1 in combination with claim 1) for sensing information relating to knock signals for instance (D4: page 2, lines 97 to 111; D5: claim 1 and page 1, paragraph 1). Thus they disclose - in the wording of claim 1 - means for sensing information relating to the combustion process, i.e. to one or more of compression, combustion, ignition and exhaust.

They further disclose that the sensed values are fed to a unit for controlling or regulating the combustion process or the injection process (D4: page 1, lines 32 to 37; D5: page 4, lines 13 to 15).

In this context it should be noted that the term "adaptive controller" of claim 1 is not explicitly defined in the application. Nevertheless, the person skilled in the art will understand it as a controller which automatically adjusts the operation of the engine in response to a monitored parameter. This view is supported by the statements on page 16, last paragraph, page 17, penultimate paragraph and in particular page 18, lines 4-6 of the application which confirm that the term "adaptive" expresses "in response to the sensed information".

Since the D4/D5 units control or regulate the combustion or injection process in response to the sensed values, the board concludes that D4 and D5 also disclose adaptive controllers for adjusting operation of the engine in the meaning of claim 1.

The appellant argued that the term "adaptive controller" would imply to employ a map for adjusting the sensed value of an engine parameter to a desired value. However, since the appellant could not identify a basis in the application in support for this argument, the board was unable to agree.

2.4.2 The purpose of this adjusting operation is not explicitly disclosed in D4 and D5. Nevertheless, the person skilled in the art will derive this information implicitly, because he knows well that the knock control systems serve to optimise the (engine) efficiency, fuel consumption and power production (see e.g. D6: page 10, middle column, penultimate paragraph - right column, first paragraph).

2.4.3 The board therefore concludes that D4 and D5 address in essence the same technical problem and solution. Consequently, it is obvious for the person skilled in the art to provide the injectors in the known combustion engines with the sensor and controller known from D4 or D5. This brings him to a combustion engine as defined in claim 1.

2.5 Substantial and unexpected advantages

2.5.1 In general, once a realistic technical problem is defined and once it is established that a particular solution to such problem would have been envisaged by a person skilled in the art in the light of the relevant state of the art, then this solution lacks an inventive step. This assessment cannot be altered by the fact that the claimed invention inherently also solves further technical problems (see T 936/96 of 11 June

1999, section 2.6, not published in OJ European Patent Office but mentioned in Case Law of the Boards of Appeal of the European Patent Office, 4th edition, I.D.7.7.1).

- 2.5.2 In this case as set out above (see item 2.4), the person skilled in the art would have used the injectors with built-in sensors of D4 or D5 in the known spark ignited combustion engines for providing a combustion engine with optimised thermal efficiency and power production and thereby have arrived at a combustion engine as defined in one of the alternative embodiments of claim 1.

Consequently, even if the board accepted the appellant's argument that the substantial and unexpected advantages are in fact achieved with the claimed combustion engine, the foregoing assessment could not be altered.

- 2.5.3 The board concludes that the considered alternative embodiment of claim 1 of the auxiliary request does not involve an inventive step as required by Article 56 EPC.

Since claim 1 of the main request includes the same alternative embodiment, its subject-matter does not involve an inventive step either.

### 3. *Clarity*

- 3.1 Article 84 EPC requires that the claims be clear. Where patentability depends on a technical effect, the claims must be so drafted as to include all the essential features of the invention which are necessary to obtain

the technical effect (see T 32/82, OJ EPO 1984, 354, section 15).

- 3.2 Claim 1 specifies in this respect that the engine incorporates an adaptive controller for adjusting operation of the engine in response to the sensed information in order to optimise one or more of thermal efficiency, power production, engine smoothness, combustion temperature control and minimisation of formation of oxides of nitrogen. However, it is not specified how the engine operation is adjusted, e.g. to minimise oxides of nitrogen or to completely avoid knock.

This definition merely amounts to claiming the underlying technical problem. Therefore, the board does not share the applicant's view that it is not necessary to specify in claim 1 how the adaptive controller is adjusted for achieving the stated advantages.

- 3.3 The board concludes that claim 1 does not include all technical features which are essential for achieving the technical effects submitted. Consequently, claim 1 does not meet the requirements of Article 84 EPC.
4. Since neither the main nor the auxiliary request is allowable, the appeal has to be dismissed.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:

G. Magouliotis

M. Ceyte