Europäisches Patentamt
Beschwerdekammern

European Patent Office
Boards of Appeal

Office européen des brevets
Chambres de recours

Veröffentlichung im Amtsblatt	Ja/Nein
Publication in the Official Journal	Yes/No
Publication au Journal Officiel	Oui/Non

Aktenzeichen / Case Number / N° du recours : T 63/88 - 3.4.1

Anmeldenummer / Filing No / N° de la demande : 82 304 003.5

Veröffentlichungs-Nr. / Publication No / N° de la publication : 0 071 474

Bezeichnung der Erfindung: Method of measuring an air to fuel ratio
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement : G01N 27/56, G01N 33/00, G01N 27/16, G01N 27/58

ENTSCHEIDUNG / DECISION

vom / of / du 31 January 1989

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent / Titulaire du brevet : Ford Motor Company Ltd, Ford-Werke AG, Ford France SA

Einsprechender / Opponent / Opposant : Pierburg GmbH & Co. KG

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56 EPC

Schlagwort / Keyword / Mot clé : "Inventive step (yes)"

Leitsatz / Headnote / Sommaire

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 63/88 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 31 January 1989

Appellant : (Opponent)
Pierburg GmbH & Co. KG
Leuschstrasse 1
D-4040 Neuss 1 (DE)

Representative :
König, Reimar, Dr.-Ing.
Patentanwälte Dr.-Ing. Reimar König
Dipl.-Ing. Klaus Bergen
Wilhelm-Tell-Strasse 14
Postfach 260162
D-4000 Düsseldorf 1 (DE)

Respondents : (Proprietor of the patent)
1) FORD MOTOR COMPANY LIMITED
Eagle Way
Brentwood Essex CM13 3BW (GB)

2) FORD-WERKE
AKTIENGESELLSCHAFT
Ottoplatz 2 Postfach 21 03 69
D-5000 Köln 21 (DE)

3) FORD FRANCE SOCIETE ANONYME
344 Avenue Napoléon Bonaparte B.P. 307
F-92506 Rueil Malmaison Cedex (FR)

Representative :
Copp, David Christopher
Dummett Copp & Co.
14 The Square
Martlesham Heath
Ipswich
Suffolk IP5 7SL (GB)

Decision under appeal : Decision of the Opposition Division of the European Patent Office dated 8 December 1987 rejecting the opposition filed against European patent No. 0 071 474 pursuant to Article 102(2) EPC.

Composition of the Board :

Chairman : K. Lederer
Members : E. Turrini
G.D. Paterson

Summary of Facts and Submissions

I. European patent No. 0 071 474 was granted on the basis of European patent application No. 82 304 003.5. The European patent comprises five claims, of which Claim 1, the sole independent claim, reads as follows:

"1. A method of measuring the air-to-fuel ratio of an air/fuel mixture which comprises adding oxygen at a predetermined rate to a stream of gases formed by combustion of the air/fuel mixture, reacting the added oxygen with oxidisable species in the gas mixture, contacting a stream of the resulting mixture with an oxygen sensing element at a predetermined pressure below atmospheric pressure which allows the stream to flow at a rate independent of the predetermined pressure, deriving from the sensor an electrical signal representing the oxygen partial pressure in the gas mixture, and determining the air-to-fuel ratio of the air/fuel mixture from the electrical signal, the rate of oxygen addition and the predetermined pressure."

II. The Appellant filed notice of opposition against the European patent and requested revocation of the patent in its entirety on the ground of non-patentability because of lack of inventive step having regard to the paper entitled "The Mixture Meter" presented by R.A. Haslett at the International Symposium on Automative Technology and Automation held at Graz, Austria from 10 to 14 September 1979, Proceedings of the ISATA 79, Volume 2, pages 199 to 206 (D1).

III. The Opposition Division rejected the opposition, considering that even if it were assumed that document D1 had actually been made available to the public at the

priority date of the patent, which the Respondents contested, this document would not have suggested the operating of the apparatus described therein at pressures meeting the pressure conditions set out in Claim 1, which therefore defined patentable subject-matter.

IV. The Appellant lodged an appeal against the decision.

V. Oral proceedings were held before the Board, at the end of which the Appellant requested that the decision under appeal be set aside and that the patent be revoked. The Respondents requested that the appeal be dismissed and that the patent be maintained unamended (main request). As an auxiliary request, they requested that the patent be maintained on the basis of a set of amended claims as filed on 27 January 1989.

VI. In support of his request, the Appellant filed further evidence to demonstrate that document D1 was part of the relevant prior art and he essentially submitted that the subject-matter of the patent failed to involve an inventive step having regard to the latter document and to the additional citation DE-C-1 947 343 (D2). In his view, the claimed method of measuring the air-to-fuel ratio of a mixture of air and fuel was distinguished from the method disclosed in document D1 only by the use of so-called "Laval nozzles" to allow the stream of gases through the apparatus to flow at a rate independent of the pressure. Laval nozzles and the characteristics of the fluid flow therethrough were however known from document D2 which also related to the art of controlling the composition of the mixture to be burned in a combustion engine as did the patent in suit. Since document D1 explicitly allowed the pressure conditions in the described apparatus to be changed (page 203, last paragraph) and since furthermore document D2 clearly

taught that critical, pressure independent operation of a Laval nozzle might be obtained by properly evacuating the space downstream of the nozzle by means of a vacuum pump (column 4, lines 54 to 59), merely reducing the pressure established in the apparatus of document D1 in order to achieve the obviously expectable advantage of stabilized flow conditions cannot by itself be considered to go beyond the normal competence of the skilled person. Also the fact that the claimed method allowed to dispense with the water separator means of the apparatus of document D1 for extracting condensed water from the analysed exhaust gases was no more than an immediate consequence of the use of lower pressures which could not therefore be considered as a separate inventive feature of the claimed method.

VII. These arguments were contested by the Respondents who, while accepting that document D1 actually was part of the prior art, submitted that the claimed method could not be derived therefrom in any obvious manner. In particular, besides the use of lower pressures, the claimed method also distinguished over the method disclosed in document D1 in that determination of the air-to-fuel ratio was obtained from the electrical signal representing the oxygen partial pressure in the mixture after reaction with the added oxygen, the rate of oxygen addition and the pressure, instead of being estimated by reference to a standard engine used in an additional calibration step, and in that it did not require any heating or trapping of water to avoid water condensation in the analysed gases. Moreover, document D1 was explicitly dedicated to low-cost monitoring of the mixture strength in engines operating under steady state conditions, whilst the claimed method also allowed mixture monitoring under transient operation, with improved accuracy. Document D2 only the use of a sonic nozzle as a means for controlling and stabilising flow conditions upstream of the nozzle, but the capacity

of such nozzles to allow samples to be drawn at a constant flow rate into a gas analysing apparatus located downstream had never been appreciated before the date of the invention.

VIII. At the conclusion of the oral hearing the decision was announced that the appeal was dismissed.

Reasons for the Decision

1. The appeal is admissible.

Main request:

2. Novelty.

2.1 Document D1 discloses a method of measuring the air-to-fuel ratio of an air/fuel mixture which comprises the steps of adding oxygen at a predetermined rate to a stream of gases formed by combustion of the air/fuel mixture (page 202, second paragraph and Figure 3), reacting added oxygen with oxidisable species in the gas mixture (page 203, second paragraph), contacting a stream of the resulting mixture with an oxygen sensing element at a predetermined pressure below atmospheric pressure (page 203, last paragraph and last sentence of page 202), deriving from the sensor an electrical signal representing the oxygen partial pressure in the gas mixture (page 203, last paragraph) and determining the air-to-fuel ratio of the air/fuel mixture from the electrical signal (page 204, last paragraph), as set out also in Claim 1 in accordance with the Respondents' main request.

According to this known method, controlled addition of oxygen to the gases formed by combustion of the air/fuel

mixture is achieved by means of a continuously switching electromagnetic valve operated in such a way as to alternately connect the stream of sample gas and ambient air, which are both at atmospheric pressure on the upstream side of the valve, to a common orifice (page 202, second paragraph), and the air-to-fuel ratio is determined from the electrical signal delivered by the oxygen sensing element by reference to the results of a specific calibration step, whereby the oxygen values obtained in the same conditions on a particular engine are associated with the corresponding air-to-fuel ratio as determined by either one of two established methods used as standards, i.e. by calculation from an analysis of the exhaust gases or by direct measurement of the air and fluid flow (page 204, second paragraph).

In contrast therewith, controlled addition of oxygen is achieved in accordance with the method of Claim 1 as granted by establishing a pressure in the reacting zone which allows the gas stream to flow at a rate independent of the pressure, whereby the flow rates of both the combustion sample and oxygen carrying gases as admitted into the apparatus can be maintained at a constant, well-defined value (description, column 6, lines 17 to 39), and the air-to-fuel ratio is determined "from the electrical signal, the rate of oxygen addition and the predetermined pressure", which in the light of the description must be interpreted as meaning that the values of these three parameters are first used to determine the fraction of oxygen originally present in the combustion exhaust gases, the air-to-fuel ratio being then obtained from the thus determined value of the fraction of oxygen to which it is directly related (column 6, lines 8 to 16).

2.2 Document D2 discloses a device for measuring and controlling the speed of a fluid, in particular the flow

of air through a carburetor, which comprises a Venturi tube operated under critical conditions in which variations of the pressure downstream of the constricted portion of the tube do not have any influence on the flow rate of the fluid through the tube. Such conditions are obtained by means of a vacuum pump connected to the downstream end of the tube (column 2, line 59 to column 3, line 3; column 3, lines 52 to 64; column 4, lines 51 to 59).

Whilst adjusting the flow of air through a carburetor indeed influences the air-to-fuel ratio of the delivered mixture of air and fuel delivered by a carburetor to a combustion engine, document D2 does not disclose any method of actually measuring such air-to-fuel ratio.

2.3 The remaining documents on file do not come closer to the subject-matter of Claim 1.

2.4 For these reasons, the subject-matter of Claim 1 as granted is considered to be novel within the meaning of Article 54 EPC.

3. Inventive step.

3.1 In the absence of any evidence on the file supporting the Respondents' submission that the method set out in Claim 1 in accordance with their main request affords the advantages of an improved accuracy or of a reduced response time to transient conditions, the technical problem to which the claimed subject-matter achieves a solution as objectively assessed in view of the nearest prior art, which both parties implicitly admitted to be disclosed in document D1, is merely to propose an alternative to the method of determining the air-to-fuel

ratio of an air/fuel mixture as known from the latter document.

3.2 This technical problem is solved in accordance with the claimed method essentially by replacing the known technique of controlling the addition of oxygen through the operation of a continuously switching electromagnetic valve by a different technique which involves establishing critical or sonic flow conditions of the gas streams entering the apparatus, and by deriving the desired value of the air-to-fuel ratio from an assessment of the original oxygen content in the combustion exhaust gas before admixture of additional oxygen, instead of using a direct relationship between the signal delivered by the oxygen sensing element and the corresponding air-to-fuel ratio as first established by way of standard methods in an extra calibration procedure conducted on a specific engine.

3.3 The Appellant did not, in the Board's view, convincingly demonstrate that the skilled person actually had any obvious reason to proceed to either one of the above defined technical modifications.

In particular, the mere indication in document D1 that the pressure in the apparatus might be changed (page 203, last but one sentence) cannot without hindsight be construed as suggesting to establish pressure conditions allowing admission of the combustion and oxygen carrying gases resulting mixture oxidized sample gas and residual oxygen to the oxygen sensing station at a predetermined flow rate independent of the pressure. Such interpretation would even appear to be in total contradiction with the further statements in the document that it was conventional practice for controlling the rate of air addition into the exhaust sample to use two orifices across which a constant

pressure had to be maintained (page 201, lines 1 to 3), and that actuation of the by-pass flow valve at the vacuum pump allowed to change both the pressure and flow conditions of the gas (page 203, last but one sentence), which consistently stress the existence of a direct dependency between the pressure and flow conditions in the apparatus. For that reason, the skilled person a priori had no obvious ground to contemplate using the technique which in document D2 is explicitly described to avoid any influence of pressure variations downstream of a nozzle on the flow rate of the fluid passing therethrough (column 3, lines 60 to 64) in the method disclosed in document D1.

As regards the choice of a different method of determining the value of the air-to-fuel ratio as set out also in the claim, document D1 clearly calls for the air-to-fuel ratio being determined from the electric signal delivered by the oxygen sensing element by reference only to the results of a prior calibration step performed on a particular research engine. The prior art as presently available lacks any hint at overcoming such calibration step in a similar method of determining the air-to-fuel ratio involving addition of oxygen to the stream of exhaust gases, completion of the oxidation reaction and measuring of the remaining oxygen content, except for the method disclosed in document EP-A-0 067 545 as referred to in the introductory portion of the description of the present patent, which however is part of the prior art in the sense of Article 54(3) EPC only and need not therefore be considered when assessing inventive step of the claimed method. Neither did the Appellant submit any argument whatsoever in support of the obviousness of such substantial change from the teaching of document D1.

3.4 For the above reasons, the subject-matter of Claim 1 is considered to involve an inventive step within the meaning of Article 56 EPC.

4. Accordingly, independent Claim 1 in accordance with the Respondents' main request is allowable under Article 52 EPC. So are dependent Claims 2 to 5 by virtue of their dependence on allowable Claim 1.

5. The opposition ground set out in Article 100(a) EPC as put forward by the Appellant therefore does not prejudice maintenance of the patent unamended.

Auxiliary request:

6. The Respondents' main request being allowable, their auxiliary request needs no further consideration.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

F. Klein K. Lederer

01085