

Publication in the Official Journal Yes / No

File Number: T 403/89
Application No.: 86 306 470.5
Publication No.: 218 346
Title of invention: Fuel control apparatus for engine

Classification: F02D 41/28 , F02D 41/04

D E C I S I O N
of 30 November 1990

Applicant: Mitsubishi Denki Kabushiki Kaisha

Proprietor of the patent:

Opponent:

Headword:

EPC Article 56, Rule 27(1)(c)

Keyword: "closest prior art"
"inventive step (yes)"

Headnote



Case Number : T 403/89 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal
of 30 November 1990

Appellant : Mitsubishi Denki Kabushiki Kaisha
2-3, Marunouchi 2-chome Chiyoda
TOKYO 100 (JP)

Representative : S.J. Hackett
MARKS & CLERK
57-60 Lincoln's Inn Fields
LONDON WC2A 3LS (GB)

Decision under appeal : Decision of Examining Division 2.3.01.101 of the
European Patent Office dated 22 February 1989
refusing European patent application
No. 86 306 470.5 pursuant to Article 97(1) EPC.

Composition of the Board :

Chairman : G. Szabo
Members : J. du Pouget de Nadaillac
L. Mancini

Summary of Facts and Submissions

- I. European patent application No. 86 306 470.5 (publication No. 218 346) was refused by decision of the Examining Division on the grounds that the subject-matter of the application as a whole lacks inventive step (as required by Article 56 EPC) in view of the prior art shown by the abstract of

JP-A-58 174 129 (1), and
GB-A-2 120 390 (2).

- II. The Appellant lodged an appeal and asked for cancellation of the above decision. He requested also the consideration of any one of the dependent claims as main claim and, further, asked for oral proceedings, if his appeal were not otherwise satisfied.)

- III. A communication of the Board drew the attention of the Appellant to the prior art described in the application in suit, which seemed to be the nearest one in the given case. Although the description was based on details already published in document (1), the latter failed to specify what kind of "air flow meter" was to be used. It was also suggested that the technical paper filed during prosecution, together with the disclosure of document (2), provided a common general knowledge basis for the interpretation of the term (as a "hot-wire air flow meter").

- IV. Oral proceedings were held on 30 November 1990. The Appellant agreed that in view of the above mentioned evidence the prior art disclosed in the application could be considered as objectively representing the closest state of the art.

The amended main Claim 1, presented during the oral proceedings, reads as follows:

"A fuel control apparatus for an engine (1) comprising:

an air flow sensor (7) for detecting the intaken air amount of the engine (1); a sensor (9) for detecting the operating speed of the engine (1); a controller (8) for calculating the fuel supply amount in accordance with the output signal of said sensors (7,9) and for clipping the detected intaken air amount to a preset upper limit value, which upper limit value is preset in response to operating characteristics including the speed of the engine (1) in the event that the air flow sensor (7) does not exhibit the true value of the intaken air amount due to the reverse-flow of the intaken air of the engine, the reverse-flow being determined by the controller (8) when the detected intaken air amount exceeds the preset upper limit value for the detected operating speed of the engine; and fuel injecting means (3) controlled by the output signal of the controller for injecting fuel to the intake passage (2) of the engine (1); characterised in that a temperature sensor (10) is provided for detecting the temperature of the intaken air, wherein, in the operating range of the engine (1) where the detected output of said air flow sensor (7) does not exhibit the true value of the intaken air amount (Qa) due to the reverse-flow of the intaken air of the engine (1), the upper limit value of the intaken air amount preset in response to the operating characteristics of the engine (1) is corrected in dependence upon the temperature of the intaken air detected by said temperature sensor (10)."

V. The Appellant requested that the decision under appeal be set aside and that a patent should be granted on the basis of the following documents:

Claims: 1, 2 and 3, as submitted at the oral proceedings,
4 to 6 as originally filed;

Description: Pages 1 to 4 and 6 to 9, as originally filed,
Page 5, as filed on 15 June 1989,
Pages 5a and 5b, as filed at the oral proceedings;

Drawings: As originally filed.

Reasons for the Decision

1. The appeal is admissible.
2. Claim 1 corresponds to the original Claim 1 with incorporation of the following additional features:
 - The operating state of the engine, which is detected by the sensor (9), is specified as being the speed of the engine. This corresponds to the disclosure in the description, page 1, lines 20 and 21.
 - The function of the controller is amplified by the feature beginning by the words " and for clipping..." (line 5) and ending with the words "operating speed of the engine" (line 15). This feature was adequately disclosed in the application documents as originally filed, see page 3, line 14, to page 4, line 4.

The Board is, therefore, satisfied that the amendments in Claim 1 meet the requirement of Article 123 (2) EPC.

3. The only issue to be dealt with is whether the subject-matter of Claim 1 involves an inventive step as required by Article 56 EPC.
4. The Board is satisfied that the closest prior state of the art is the one disclosed in the description of the application, pages 1-4. The known fuel control apparatus acknowledged by said description corresponds to the fuel control apparatus disclosed by document (1), To the skilled person the required "air flow meter" could only be in practice a hot-wire air flow sensor. In this technical field, such kind of sensor is the one commonly used, as shown by the documents already mentioned in Point III, and it is to be assumed consequently that, under the expression "air flow meter" of document (1), this kind of sensor is to be understood. The Applicant has admitted this as a fact.

Previous decisions of the Boards have pointed out the necessity of starting from the objectively existing state of the art in order to achieve objectivity in the assessment of inventive step (cf. for example, T 248/85, OJ EPO 1986, 261). According to these decisions, if a prior art is discussed in an application, such prior art should be checked for availability. Rule 27(1)(c) mentions the citation of a document reflecting such prior art. This condition is satisfied in the present case in view of the express and implied disclosures of document (1).

5. The fuel control apparatus known from this closest prior art comprises all the features of the preamble of Claim 1, namely an air flow sensor for detecting the intaken air amount of the engine, a speed sensor, a controller for calculating the fuel supply amount in accordance with the

outputs of both sensors and fuel injecting means driven by the controller. Said controller is a computer, which calculates the drive pulse width of the fuel injection means, and thus the air-fuel ratio, by dividing the intaken air amount by the rotating speed of the engine. A precise measurement of the intake air flow rate is, therefore, important. However, at low speeds, this rate fluctuates considerably. For this reason, a hot-wire air flow sensor using the constant temperature principle is mostly used, since the temperature recovery process of this kind of sensor is very fast and gives a correct air flow amount measurement, even when said flow fluctuates. Furthermore, at such low speeds, when the piston takes a position around the top dead center, both of the intake valve and the exhaust valve are opened simultaneously and the intake air is forced back by the pressure, which acts to reverse the flow of gas from the exhaust valve to the intake valve. The said hot-wire air flow sensor has, however, the drawback that it cannot detect the direction of flow of the air and, consequently, adds this reverse flow to its output, so that a falsification of the intake air flow signal occurs.

The computer, in said prior art, is, therefore, programmed to overcome this problem of reverse flow. Since such flow takes place when the throttle flap is almost fully opened, so that the intake air amount is near its maximum for a given speed of the engine, a corresponding preset upper limiting air amount or value depending upon the speed of the engine is stored in the computer: Each time and as long as the detected value of the air flow sensor exceeds this limit value, showing thereby the presence of reverse flow, it is clipped, i.e reduced to this value.

This specific air flow sensor comprises, in addition, as integral component of the sensor, a temperature dependent resistor, which compensates for the influence of

temperature fluctuations in the intaken air. Placed on one arm of the bridge circuit of the sensor, this resistor compensates for the effects of intake air temperature on the air flow sensor itself.

6. The present invention aims to provide an improvement in such a fuel control apparatus, since it was experienced that, at high or low temperatures, the air-fuel ratio becomes either too rich or too lean.
7. To solve this problem, the apparatus of the present invention measures the intaken air temperature by way of a temperature sensor, and a correction of the upper limit value of the intaken air amount is generated by the controller in dependence on this measurement. It should be noticed that, in the present invention, the specific kind of air sensor of the closest prior art, namely the hot-wire air sensor, is not mandatory, as it constitutes only the subject-matter of dependent Claim 2. It may nevertheless be preferred for other technical reasons (e.g. no altitude error and very fast measurement of the air flow amount).
8. The person skilled in the art would not have guessed with any certainty that there may be a relationship between his problem and the reversal flow phenomenon. For this reason, one aspect of the invention resides in the finding of this connection, namely that the reverse flow with its elevated temperatures has a significant effect on the temperature of the intake air. This effect, and consequently, the relevant relationship, is nowhere suggested or directly recognisable in the said closest prior art or its use.
9. As in the closest state of the art, a compensation for the influence of temperature fluctuations is indeed provided by such a solution. However, this kind of compensation cannot be suggested on the basis of the one used in the said

closest prior art, since the object is different there. The purpose of the compensation according to such art is to obtain a precise value of the air flow, whilst the present invention also compensates for the reversal of the flow.

These two kinds of compensation cannot be considered as equivalent either, since not only are their objects different, but also the results must be assumed to be different, otherwise their simultaneous presence in the apparatus makes no sense. Equivalency can only be established when the means at least produce the same technical effect. In the present case, the same technical effect is not achieved and the principles of operation are also different: The temperature dependent resistor disposed in one branch of the bridge of the air flow sensor according to the closest prior art compensates for the influence of the temperature of the intaken air on the temperature of the first resistor, which is placed on the other branch and is used to measure air flow. In the present invention, the output of an air temperature sensor is directly connected to the computer, which varies the upper limit value in accordance therewith and provides thereby a different effect.

10. The Board cannot agree to the Examining Division's assertion that the closest prior art teaches that the upper limit value is a function of the temperature of the intake air: Fig. 4 of document (1) only shows that the upper limit value is preset in dependence on the speed, which is the sole parameter. No incentive to take into consideration a further or several other parameters can be found in this prior art for setting up the upper limit value.

11. The Examining Division also argued that the man skilled in the art, having to preset the upper limit value according to the prior art, would adopt a theoretical approach and

determine the upper limit value by considering the ideal gas law, which should show him that this value was a function of the temperature. This argumentation cannot be followed for the following reasons:

- (a) It is first very questionable if such a theoretical approach should be followed. The reason given by the Examining Division therefor is that, with an experimental approach, the specialist does not know what parameters are to be considered, whereas, with the theoretical approach, the law gas ($V_{lim} = n \cdot \lim RT/P$) teaches him, as parameters, the temperature (T) and the atmospheric pressure (P), R being the gas constant. Such reasoning is in contradiction with the previous, above mentioned assertion of the Examining Division (see point 10), according to which the skilled man would learn from the prior art, that the upper value is a function of the temperature, so that he should know which parameter is to be considered with an experimental approach. Moreover it is not explained why the choice is only the temperature and not the pressure. Further, the specialist in this field knows that many other parameters could play a prominent part, like, for example, the residual gas in the cylinder or its temperature. Facing the complexity of these conditions, he is more likely to follow an experimental approach than a theoretical one. The diagrams shown in both prior art documents are the results of experiments, and do not follow the ideal gas law.

- (b) The closest state of the art, as seen above, already compensates for the influence of the temperature fluctuations in the air intake. The output of the air flow sensor provided to the controller is a value, which takes into account the temperature variations,

corresponding therefore to a value at ambient temperature. Since, in this known process, this value is compared with the upper limit value, already preset at an ambient temperature, it is unclear, in this case, why the specialist should once more compensate for temperature. He did not only consider the way the upper value was to be preset, but would also have taken account of the conditions, under which this value was used in the process. By doing so, he would have immediately seen that this value, previously preset at ambient temperature and stored in the computer, was compared to the air flow value, which in turn was itself already corrected in dependence of the temperature, being thereby virtually controlled by the same conditions as the upper value, including "ambient temperature". Therefore, the temperature parameter determined by the gas law was already taken into account and a new consideration of this parameter for the determination of the upper value could not have appeared useful in the given circumstances.

12. For all these reasons, the closest state of the art gives no hint in the direction of the invention.

13. Document (2), which was considered by the Examining Division because of its disclosure of temperature compensation, does not add further information to that already taken into account with regard to the closest prior art. Although it relates to a similar fuel control apparatus and is also concerned with the same problem of reverse flow, its solution is achieved by a different method, in which the correction for the reverse flow is carried out in the computer by reversing the polarity of the detected air flow value for the time interval, during which the detected air flow exceeds an upper reference value. No clipping operation occurs in the method according

to this document (2). The temperature compensation mentioned for the air flow sensor is exactly the same as in the above closest prior art. A consideration of this document is, therefore, of no value. The same applies for other documents in these proceedings.

14. The subject-matter of Claim 1 is, consequently, not derivable in an obvious manner from the state of the art and thus involves an inventive step according to Article 56 EPC. Claims 2 to 6, being appendant to Claim 1, are also valid.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.
2. The file is remitted to the first instance with the instruction to grant a patent on the basis of the documents as defined in Point V.

The Registrar:

The Chairman:



S. Fabiani



G. Szabo

