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Datasheet for the decision of 17 June 2008

Case Number: T 0052/06 - 3.4.02

Application Number: 97930808.7

Publication Number: 0912880

IPC: G01M 15/00

Language of the proceedings: EN

Title of invention:
Method of testing assembled internal combustion engine

Applicant:
Toyota Jidosha Kabushiki Kaisha

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step - main request, auxiliary request 1 (no)"
"Inventive step - auxiliary request 2 (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0052/06 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 17 June 2008

Appellant: Toyota Jidosha Kabushiki Kaisha
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Representative: TBK-Patent
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 5 August 2005 refusing European application No. 97930808.7 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: A. Klein
Members: M. Rayner
M. J. Vogel

Summary of Facts and Submissions

I. The applicant appealed against the decision of the examining division refusing European patent application number 97 930 808.7 (International Publication No. WO 98/03846). The patent application concerns testing an assembled internal combustion engine. In the decision under appeal, reference was made to documents including the following:

D2 US-A-5 355 713.

In the decision under appeal, the examining division reached the view that the subject matter of claim 1 according to both the main and auxiliary request presented to it lacked novelty over document D2. In relation to timing of change of pressure, the division observed that document D2 discloses that a pressure pulse in the exhaust valve side space must have a particular timing, which is checked. The pulse takes a maximum value by definition. Thus, even if judging by crankshaft angle were considered novel, there would be no inventive step in use of available data, there being no difference from the data disclosed in document D2, to judge whether there is a fault. In relation to the dependent claims, the division observed, inter alia, that document D2 described a number of technical faults that can be detected by analysis of the timing of the pressure conditions. It would be obvious for the skilled person to judge whether there is one of these faults with assembling the engine.

II. In its appeal, the applicant requests that the decision under appeal be set aside and that a patent be granted

on the basis of documents filed with its letter of 07.05.2008 as a main or auxiliary request 1 or on the basis of claims filed on 17.06.2008 as auxiliary request 2. Oral proceedings were requested on an auxiliary basis. According to the applicant, there is, in document D2, no teaching of obtaining an angular amount of deviation from a normal angle, in contrast with claim 1 as amended on appeal. From the whole of the teaching of document D2, the "angle of the engine operating cycle" means a normal or proper angle. Any determination is just that of a different angle. Therefore, as different faults cause different angles, the teaching of document D2 does not permit identifying at least one fault out of a plurality of these faults.

III. The wording of the independent claims of the main and auxiliary requests of the appellant is as follows.

Main Request

"1. A method of testing an assembled internal combustion engine having a crankshaft (18), an intake valve (50) and an exhaust valve (48), the method including the following steps:

rotating the assembled engine;

continuously measuring, while the engine is rotated, a pressure in at least one of an external intake—valve side space (92) which communicates with the intake valve (50) and an external exhaust—valve side space (100) which communicates with the exhaust valve (48);

obtaining, based on the continuously measured pressure, angle values of the crankshaft (18) at which at least one predetermined mode of change of the

pressure in said at least one of the external intake-valve side space (92) and the external exhaust—valve side space(100) occurs;

obtaining an angular amount of deviation of the obtained angle value of the at least one predetermined mode of change of the pressure from a normal angle value of the at least one predetermined mode of change of the pressure; and

identifying, based on the obtained angular deviation amount, at least one kind of fault out of a plurality of kinds of faults of the engine which can result from the assembling of the engine."

Auxiliary Request 1

"1. A method of testing an assembled internal combustion engine having a crankshaft (18), an intake valve (50) and an exhaust valve (48), the method including the following steps:

rotating the assembled engine;

continuously measuring, while the engine is rotated, a pressure in at least one of an external intake—valve side space (92) which communicates with the intake valve (50) and an external exhaust—valve side space (100) which communicates with the exhaust valve (48);

obtaining, based on the continuously measured pressure, angle values of the crankshaft (18) at which at least one predetermined mode of change of the pressure in said at least one of the external intake-valve side space (92) and the external exhaust—valve side space(100) occurs;

obtaining an angular amount of deviation of the obtained angle value of the at least one predetermined

mode of change of the pressure from a normal angle value of the at least one predetermined mode of change of the pressure; and

identifying, based on the obtained angular deviation amount, at least two kinds of fault out of a plurality of kinds of faults of the engine which can result from the assembling of the engine."

Auxiliary Request 2

"1. A method of testing an assembled internal combustion engine having a crankshaft (18), an intake valve (50) and an exhaust valve (48), the method including the following steps:

rotating the assembled engine;

continuously measuring, while the engine is rotated, a pressure in at least one of an external intake—valve side space (92) which communicates with the intake valve (50) and an external exhaust—valve side space (100) which communicates with the exhaust valve (48);

obtaining, based on the continuously measured pressure, angle values of the crankshaft (18) at which at least two predetermined modes of change of the pressure in said at least one of the external intake-valve side space (92) and the external exhaust—valve side space(100) occur, wherein the angle-value obtaining step comprises obtaining, as the angle values of occurrence of the at least two predetermined modes of change of the pressure, at least two of a first angle value when the exhaust pressure in the exhaust-valve side space (100) takes a maximal value; a second angle value when the exhaust pressure changes from a first decreasing state to a constant state in which the

exhaust pressure does not change as time elapses; a third angle value when the exhaust pressure changes from the constant state to a second decreasing state; a fourth angle value when the intake pressure in the intake-valve side space (92) takes a maximal value; and a fifth angle value when the intake pressure changes from a constant state in which the intake pressure does not change as time elapses, to an increasing state;

obtaining a combination of angular amounts of deviation of the respective obtained angle values of the at least two predetermined modes of change from respective normal angle values of the at least two predetermined modes of change; and

identifying, based on the obtained combination of angular deviation amounts, at least two kinds of faults out of a plurality of kinds of faults of the engine which can result from the assembling of the engine."

IV. Consequent to the auxiliary request of the appellant, oral proceedings were appointed. In a communication attached to the summons, the board indicated that it was true that the angular amount of deviation is not obtained according to document D2, only that the angle is not as it should be. Nevertheless, it was difficult to follow the argument of the appellant relating to identifying faults because the claim refers to at least one fault, in other words, just the maximum exhaust pressure, as with the prior art, is enough. While the board understood that the appellant argued that, in relation to document D2, the problem solved by the subject matter claimed was that of enhancing defect determination, this argument does not therefore seem correct. In fact, the novel subject matter claimed seemed to amount to no more than an unnecessary further

step, it seeming doubtful whether any technical problem at all was solved. Therefore, the board doubted whether the applicant would succeed in persuading the board that a patent should be granted.

V. During the oral proceedings, the appellant explained the method claimed in relation to the detailed description. It was important that in document D2, all that is determined is pressure amplitude for determining one fault, after which the method stops for resolution of the problem. In the invention, it is the angular amount of deviation which is determined leading to the possibility of determining one fault from many and then stopping. In particular the value of, for instance Γ, which is the exhaust pressure maximal-value angle difference, allows determination of fault in intake valve clearance such as large intake valve clearance as shown in Figures 9, exemplary of what is claimed in claim 1 of the main request. Details can be seen in Figure 24, showing values obtained and also in relation to large intake valve clearance in the logic in Figure 32, e.g. step S606. This is not disclosed or suggested by document D2. Therefore, the subject matter of claim 1 of the main request can be considered to involve an inventive step. According to auxiliary request 1, the claim is further limited to determining two faults. According to the second auxiliary request, the claim is even further limited to determining two faults from a combination of two angular amounts of deviation, i.e. not only Γ but, for instance, also Φ, which is the exhaust-pressure decrease-start-angle difference. It is not possible to reach the subject matter of either of the auxiliary request in an obvious way from the prior art available. Therefore, the

subject matter of claim 1 of both auxiliary request 1 and 2 can be considered to involve an inventive step. The representative of the appellant indicated that should the board have a positive view only in relation to auxiliary request 2, remittal to the first instance for adaptation of the application would be preferred in view of the complexity of changes needed to be made, having regard also to division.

VI. At the end of the oral proceedings, the board gave its decision.

Reasons for the Decision

1. The appeal is admissible.

2. *Prior Art*

2.1 Document D2 concerns cold engine testing on the production line wherein the crankshaft of the engine is rotated by an auxiliary motor instead of operating the engine under its own power. The pressure waveform in intake and manifolds is analyzed so that peaks and valleys of the waveform can be compared with a reference waveform for a normal engine, permitting permits findings regarding potential faults in the cylinder valves. The vacuum pulses developed at the intake manifold take the form of unique signatures. A properly assembled "good engine", will develop one type of signature while defective engines will exhibit uniquely different signatures.

2.2 Valves are actuated by the camshaft and a linkage mechanism which may include a push rod, lifter and rocker arm. Lost motion in the linkage affects the timed relationship of the piston and valve actuation and is referred to as valve lash. Valve lash will affect the air intake pulses because it results in an imbalance in the air flow velocity in and out of the cylinder. Examples of valve train faults include soft or collapsed lifters, lifters stuck open, bent pushrods, wrong camshaft, loose rocker arm pivot bolts and unmachined seats or valve faces. A comparison of peak value and/or width of each test pulse with established values of a normal pulse can be done. An exhaust valve with a lash defect causes a vacuum pulse to have a larger amplitude or peak value whereas other vacuum pulses and the pressure pulses are substantially unaffected and can be detected by comparison of the recorded amplitude of the test vacuum pulse with that of the normal vacuum pulse. Intake valve lash defect causes a vacuum pulse in the exhaust manifold to have a smaller amplitude. A stuck-open exhaust valve causes an interval of a substantially zero pressure instead of a normal vacuum pulse and is taken as an indication of a stuck open exhaust valve. A stuck-open intake valve affects the pressure waveform in the exhaust manifold by an increase of the amplitude of a vacuum pulse and a decrease of the amplitude of the succeeding pressure pulse.

2.3 By means of a pressure transducer for sensing the pressure at the exhaust passage of an individual cylinder, a test is conducted to determine whether the camshaft is installed wrongly. In an engine, the exhaust valve for number one cylinder starts to open at

one hundred fifteen degrees after top dead centre. At this point, the pressure in the exhaust passage increases and produces a pressure pulse which is measured by the transducer. If the pressure pulse amplitude does not exceed a certain normal value, it is taken as an indication that the camshaft was not installed correctly. The test procedure analysis comprises a series of tests performed at a test stand. The test program is conducted under computer control. The computer sets the engine speed cam timing is checked by determining whether number one cylinder exhaust pressure is at the prescribed pressure in the proper timing. If not, it indicates that the camshaft was installed wrongly and the computer rejects the engine. In the test procedure with exhaust pulse analysis, the computer checks the exhaust pressure under computer control by comparing the computed average value with a normal value. If not correct the program rejects the engine with the appropriate test tag. If the exhaust pressure is correct, the computer goes to checks the cylinder valves by comparing the exhaust pulses with the normal pulses. If a fault is detected the program proceeds to reject the engine and tag it accordingly.

3. *Patentability - Main Request*

3.1 A comparison of the features recited in claim 1 with the disclosure of document D2 reveals that the last two features of the claim can be considered novel because the angular amount of deviation is obtained, whereas according to document D2, in, for example, the camshaft test, it is simply determined that the pressure pulse amplitude does not exceed a certain normal value at the

expected angle after top dead centre, in other words that the angle is not that which it should be. This is used to identify the fault. Since there is a plurality of kinds of faults identifiable according to the teaching of document D2, the problem solved by the novel subject matter can be seen as that of providing another way to identify at least one of the faults, for instance the camshaft fault, resulting from assembly of the engine.

3.2 The skilled person reading document D2 knows, of course, the amount of angular deviation expected for a good camshaft, because this is just another way of expressing the expected angle after top dead centre. Therefore, knowledge of the angular "amount of deviation" for a good camshaft is set initially in the computer and failure to achieve this directly indicates the fault. Obtaining an amount of deviation (Γ), as in the method of claim 1 of the main request, as a preliminary to identifying that it is not the expected value set in the computer amounts to providing an obvious alternative in the form of subsequent extra comparison step compared with the method of document D2, which does not help in identifying the camshaft fault, as in both cases, the pressure did not occur at the expected angle for a good camshaft. Whether or not the unnecessary subsequent step is taken, i.e. whether the angle information is a preliminary data entry or compared in a subsequent step, amounts to no more than an obvious choice for the skilled person. The board therefore reached the conclusion that the subject matter of claim 1 of the main request cannot be considered to involve an inventive step.

4. *Patentability - Auxiliary Request 1*

4.1 This request differs from the main request in identifying not at least one kind of fault as in the main request but at least two kinds of faults. What this means is that the amount of deviation in the terms of the claim, or the angle after TDC in the terms of document D2, of the pressure maximum is used to identify two kinds of fault, where, for instance, the pressure maximum occurs at a differing angle. The problem solved by this difference is thus to improve the method by identifying another fault.

4.2 It is true that document D2 is not very detailed, but nevertheless, the reference to one hundred and fifteen degrees after TDC is given as only as an example that the pressure should be above a certain value at a given crankshaft angle in detecting the camshaft fault. The board agrees with the examining division that document D2 described a number of technical faults that can be detected by analysis of the timing of the pressure conditions. The skilled person is aware of the timings concerned and accordingly, in terms of the claim, the expected amount of angular deviation when identifying the faults concerned (stuck open valves, valve lash). The skilled person must thus be expected to use the respective angle after TDC, as taught for the camshaft fault, also in determining such valve faults, i.e. to identify at least two kinds of fault. In doing this the subject matter of the claim is, as "more of the same" rendered obvious in the same way as for the main request. Accordingly, the board reached the conclusion that the subject matter of claim 1 of auxiliary request 1 cannot be considered to involve an inventive step.

5. *Patentability - Auxiliary Request 2*

A different situation exists in relation to this auxiliary request because a combination of angular amounts of two modes of change is obtained. In other words, for instance not only Γ, the exhaust pressure maximal-value angle difference, but also, say, Φ, which is the exhaust-pressure decrease-start-angle difference, are involved. It is difficult to see how "not occurrences" of pressure peaks as disclosed in document D2 could be combined. Moreover, the angle values concerned are specified in relation to the exhaust pressure and thus are more precise than the general indications in document D2. Accordingly, the board reached the view that the subject matter of claim 1 cannot be reached in an obvious way from the teaching of document D2 and thus that it can be considered to involve an inventive step within the meaning of Article 56 EPC.

Nor do the remaining documents in the file affect the positive view of the board in relation to inventive step. In principle, the basis for grant of a patent is thus present.

6. *Remittal to the first instance*

6.1 While the board is satisfied as to inventive step of the subject matter of the claims according to the second auxiliary request, the remainder of the description nevertheless requires very careful adaptation to ensure that matter inconsistent with the independent claim is not presented as part of the

invention, as such a situation would introduce a lack of clarity. In making the adaptation, care should also be taken not, inadvertently, to proceed in a way so as to introduce added subject matter.

6.2 In view of the complexity of the amendments needed in a 196 page description with 76 sheets of figures, the representative preferred to make the amendments before the examining division rather than under time pressure before the board. Despite the delay introduced, this is not an unreasonable position and the board therefore reached the view that remittal of the case was appropriate.

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 grant a patent on the basis of claims 1-14 (Second Auxiliary Request) filed during the oral proceedings and description and drawings to be adapted.

The Registrar The Chairman

M. Kiehl A. G. Klein