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Bezeichnung der Erfindung: Internal combustion engine piston

Title of invention:

Titre de l'invention :

Klassifikation / Classification / Classement : F02B 23/06

ENTSCHEIDUNG / DECISION

vom / of / du 27 October 1989

Anmelder / Applicant / Demandeur : Perkins Engines Group Limited

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence : Piston

EPÜ / EPC / CBE Art. 56 EPC

Schlagwort / Keyword / Mot clé : "Inventive step - yes; not obvious to carry out experimental tests"; "Diagrammatic representations"

Leitsatz / Headnote / Sommaire

Europäisches
Patentamt

Beschwerdekammern

European Patent
Office

Boards of Appeal

Office européen
des brevets

Chambres de recours



Case Number : T 521/88 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 27 October 1989

Appellant : Perkins Engines Group Ltd.
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Representative : Jones, David, Bryn
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Decision under appeal : Decision of Examining Division 101
of the European Patent Office
dated 3 June 1988 refusing European
patent application No. 84 902 533.3
pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : G. Szabo
Members : C. Andries
L. Mancini

Decision

Summary of Facts and Submissions

- I. European patent application No. 84 902 533.3 filed on 25 June 1984 as an International application PCT/GB84/00224 and published under the international publication number WO 85/00198 was refused by a decision of the Examining Division dated 3 June 1988. The decision was based on Claims 1 to 6 filed with letter dated 13 January 1987.
- II. During the examination procedure the Appellant filed, with letter dated 3 November 1987, test results additional to those of Figures 11 and 12, for a set of pistons with a ratio as claimed of 0.12 (modified Figures 11 and 12: curves 4) (Document D4).
- III. The reason given for the refusal was that the subject-matter of Claims 1 to 6 did not involve an inventive step in view of the prior art disclosed in

D1: GB-A-509 838,
D2: DE-A-2 407 783,
D3: US-A-4 176 628,

and in view of the normal tasks and capacities of a skilled engineer.
- IV. The Appellant filed a Notice of Appeal against this decision on 30 July 1988. The appropriate fee was paid on 28 July 1988. The Statement of Ground was filed by telecopy on 3 October 1988 and confirmed on 8 October 1988.

- V. In reply to Communications of the Board, the Appellant submitted revised pages of the description, a new set of claims and modified drawing sheets.

The independent Claim 1 on file reads as follows:

"An internal combustion engine piston having a combustion bowl (3) recessed in the crown (1) of the piston and a plurality of recesses (7) formed in the side wall (6) of the bowl (3), so as to extend substantially the full depth of the bowl (3), each recess (7) having a cross section in the form of an arc of a circle, having a centre (c) which lies on a circle which is concentric to the bowl (3), and being spaced from a neighbouring recess by an arcuate intermediate portion of the side wall (6), characterised in that the ratio of the maximum distance by which each recess (7) extends radially into the side wall (6) compared with the radius of the side wall (6) lies within the range 0.10 to 0.20."

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

- Claims 1 to 4 as filed with letter dated 1 September 1989;
- description: pages 1, 2, 4 to 7, 9 and 10 as originally filed and published;
page 3 as filed with letter dated 1 September 1989; and
page 8 as filed with letter dated 12 July 1989;
- drawings: sheets 1/9 and 6/9 to 9/9 as filed with letter dated 1 September 1989;

sheets 2/9 to 4/9 as originally filed and published; and
sheet 5/9 as filed with letter dated
12 July 1989.

Reasons for the Decision

1. The appeal is admissible.
2. There are no formal objections under Art. 123(2) to the present text of the patent application since the proposed amendments (in the description, claims and drawings) are adequately supported by the original disclosure.
 - 2.1 Present Claim 1 is supported by the description (pages 5, lines 24 to 26; page 6, lines 2 to 8) and the drawings (Figures 2 and 10) for the feature that the recesses extend substantially the full depth of the bowl, and by the originally filed Claims 1 to 3 for the rest of its features.
 - 2.2 Claims 2 to 4 correspond to Claims 4 to 6 as originally filed.
 - 2.3 The modifications of the description and the drawings only relate either to the adaptation of the description to the present claims, or to obvious errors, and are, therefore, allowable.
3. **Novelty**

After examination of the cited documents, the Board is satisfied that none of them discloses an internal combustion engine (i.c.e.) having all the features as defined in Claim 1.

Since this has never been disputed, there is no need for further detailed substantiation of this matter.

Therefore, the subject-matter as set forth in Claim 1 is to be considered novel within the meaning of Art. 54 EPC.

4. The problem and the solution

- 4.1 The patent application relates to an i.c.e. piston according to the pre-characterising portion of Claim 1. Such an i.c.e. piston is known from Figs. 7 and 8 of document D1.
- 4.2 Pistons used in a diesel engine of the direct injection type are commonly provided with an open combustion bowl, recessed in the crown, so as to allow improved fuel/air mixing and combustion. It is known to modify the shape of the combustion bowl in order to induce turbulence in the swirling flow of air and fuel in the bowl, thereby further increasing the rate of air/fuel mixing and hence improving the rate of heat release. This in turn allows the engine to be operated at more retarded fuel injection timings at which lower oxides of nitrogen emissions are produced, without increasing the specific fuel consumption or smoke emission.
- 4.3 The piston according to Figs. 7 and 8 of document D1 has a combustion bowl (13) provided with cylindrical recesses which extend from the end face of the piston to the end wall (17) of the bowl.

The effective cross-section of the cavity (bowl and recesses) is therefore substantially uniform from its mouth to near its end wall. It is indicated in document D1 (page 2, lines 73 to 90) that for a given cylinder diameter there is an optimum value for the size of the

cross-section of the cavity at which the best results are secured. The recesses provide now a longer available path for the fuel, so that the injected fuel is avoided to contact the relatively cold wall of the cavity, without appreciably varying the effective cross-section or shape of the cavity. The suggested form permits improved mixing to be secured with the size of the cavity at an optimum value.

- 4.4 The technical problem to be solved in respect of document D1 consists in providing a combustion system that gives a further improved specific fuel consumption and smoke performance over a wide range of engine speeds (cf. page 2, last paragraph of the present application).
- 4.5 The Board accepts that this problem is successfully solved by the features specified in Claim 1, in particular by the relative degree of extension of the recess into the side wall expressed as a characteristic ratio of 0.1 to 0.2 in relation to the radius of the wall. In view of the results shown in Figs. 11 and 12 of the patent application as well as those submitted in document D4, it is convincing that the indicated specific range of the defined ratio corresponds to a number of specific cavity constructions, wherein the recesses are sufficiently deep to produce a required turbulence for air/fuel mixing at all speeds but not too deep to have a detrimental effect on the swirling air motion at low engine speeds. Improved specific fuel consumption as well as improved smoke emission performances are obtained when compared with i.c.e. pistons having a ratio outside the claimed range.
5. **Inventive step**
- 5.1 A person skilled in the art, starting from an i.c.e. piston according to document D1, who would try to obtain a

piston allowing the solution of the above problem, could not find, however an indication or an encouragement in the cited documents to use the specific range of the ratio as defined in Claim 1.

- 5.2 Document D1 only indicates that for a given cylinder diameter, there is an optimum value for the size of the cross-section of the cavity, at which the best results for the mixing of air and fuel are obtained (page 1, lines 52 to 70). A skilled person is taught thereby, that the best mixing is linked to a specific relation between the cylinder diameter on the one hand and the cross-section size of the cavity on the other.

Furthermore, according to page 1, lines 59 to 70, it seems that it was intended that the engine according to document D1 should avoid contact of the injected fuel with the recess wall, which is a condition implying an intricate relation between several parameters, among others the injection pressure of the fuel, the air pressure, the air velocity (depending itself on the relation diameter cylinder/cavity cross-section), the length of the recess, etc. In view of this, a skilled person would rather be led to optimise those particular parameters in combination with each other. He would also appreciate that for an increased fuel injection pressure a deeper recess is needed (while keeping constant the other parameters), but this is then not dependent of the radius of the wall.

- 5.3 The Board cannot detect, however, either in the above considerations or in the other parts of document D1, any suggestion to the ratio as claimed - as such - or to the fact that the limited ratio may be important or critical for improving the mixing of fuel and air, particularly since it is, according to document D1, rather the ratio between the diameter of the cylinder (in other words the

diameter or the cross-section of the piston) and the cross-section of the cavity which is most important and relevant for mixing purposes. It is therefore, according to the Board, not obvious for a skilled design engineer or for a person skilled in the art, to start carrying out systematic experimental tests to optimise only the critical ratio of the present application, without having any expectation that such a ratio is advantageous for mixing purposes. Instead, there was a clear encouragement to ascertain the optimum recess depth with respect to the fuel injection pressure, so that such inquiry might have been obvious. However, the suggested relationship between recess depth and fuel injection pressure has in no way implied or suggested the claimed ratio itself, which is independent of pressure.

Indeed, according to the jurisprudence of the Boards, the question to be answered when assessing inventive step is not whether the skilled could have made these peculiar experimental tests, but whether he would have done so in expectation of some improvement or advantage (decision T02/83 "Simethicone Tablet/RIDER", OJ EPO, 1984, 265). As explained above, there was no reason to move towards the invention by investigating the relative extent of the recess beyond the wall. Furthermore, it should be kept in mind that the peculiar piston cavity-form as shown in the pistons according to Figures 7 and 8, is only one form out of a number of completely different cavity configurations, disclosed in document D1, so that even the choice of the form according to Figures 7 and 8 represents an additional choice without any particular initial advantage. Without an ex-post facto analysis a skilled person would not have been led by the content of document D1 to start experimental tests to optimise precisely the ratio in question.

- 5.4 Furthermore, the Board cannot agree with the statement of the Examining Division that document D1 shows already an embodiment having a ratio very close to the claimed range. Indeed, according to the jurisprudence of the Boards, dimensions obtained merely by measuring a diagrammatic representation in a document do not form part of the disclosure (decision T 204/83, "Venturi/CARBONNAGES", OJ EPO, 1985, 310). This decision was, of course, only concerned with novelty where absolutely accurate figures may be required to establish anticipation. Some trends shown by visible rough proportional impressions might not be completely dismissed when considering the inventive step, since those could influence the thinking of the skilled person. Although document D1 indicated that the invention there was not restricted to the precise constructional details of the drawings, there would have been no good reason or justification to depart from the 0.25 ratio measured by the Examining Division on the drawing, and further away from this, specifically in the direction of lower ratios, to end up in the specified range, in view of the above considerations.
- 5.5 Neither is there any suggestion in other documents which would suggest or imply the use of the claimed proportions. The teaching of both documents D2 and D3 aim at an improved combustion and provide a specific form for the recesses (cf. the respective Claims 1). The cross-sections of these well defined recesses are not in the form of an arc of a circle, and create therefore flow characteristics which are different from those generated by the claimed cross-sections. The Board is of the opinion that such differently defined cross-sections (resulting in different flow characteristics), as well as all the conditions put forward in these documents relating to parameters of these specifically defined shapes (e.g. document D3: column 4, lines 38 to 41; document D2: page 8, second paragraph)

which influence thereby the flow characteristics, cannot suggest to a skilled person the idea of optimising the ratio of other parameters of other, different cross-sections, particularly since the flow characteristics are already different. Document D2 also states (page 4, lines 16 to 22) that recesses having a part-circular cross-section are not so good as those particularly disclosed. The ratios in question have never been suggested in either of these documents.

- 5.6 Furthermore, as already indicated above (Point 5.4), dimensions obtained merely by measuring the diagrammatic representations in documents D2 and D3 do not form part of the disclosure, particularly since not all of the used dimensions are disclosed in the descriptions of these documents, so that the statement of the Examining Division, that the claimed ratio is already shown in the documents D2 and D3, cannot be accepted.

Therefore, there is no basis in these documents to derive any need for a particular restriction of the relative position of the recesses, as it is done in the present claims, let alone the specific value range represented by the claimed ratios. There was no expectation that such limitation would provide further advantages, on top of those already achieved by the cited closest state of the art.

- 5.7 The Board has also considered the further documents cited in the proceedings and found them not prejudicial to the present Claim 1 neither alone nor in combination with the documents cited above.

Therefore, the subject-matter of Claim 1 involves an inventive step within the meaning of Art. 56 EPC.

6. Based upon the allowable Claim 1 and dependent Claims 2 to 4 which concern preferred embodiments of the piston according to Claim 1 as well as an internal combustion engine comprising said piston, and the adapted description as well as the drawings, a patent may be granted.

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 European patent on the basis of the documents as defined in Point VI.

The Registrar:

The Chairman:

S. Fabiani

S. Fabiani

G. Szabo
G. Szabo

Sous. G.
16/11/88