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D E C I S I O N
of 18 May 1994

Case Number: T 0428/91 - 3.2.4

Application Number: 85904653.4

Publication Number: 0193591

IPC: F02F 3/00

Language of the proceedings: EN

Title of invention:
Improvements in or relating to pistons

Patentee:
AE PLC

Opponent:
Mahle GmbH

Headword:
-

Relevant legal norms:
EPC Art. 56

Keyword:
"Inventive step (yes)"
"Closest state of the art"

Decisions cited:
-

Headnote/Catchword:



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Boards of Appeal

Chambres de recours

Case Number: T 0428/91 - 3.2.4

DECISION
of the Technical Board of Appeal 3.2.4
of 18 May 1994

Appellant: Mahle GmbH
(Opponent) Pragstrasse 26-46
D-70376 Stuttgart (DE)

Representative: -

Respondent: AE PLC
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Decision under appeal: Interlocutory decision of the Opposition Division
of the European Patent Office dispatched on
23 April 1991 concerning maintenance of European
patent No. 0 193 591 in amended form.

Composition of the Board:

Chairman: C.A.J. Andries
Members: M.G. Hatherly
J.P.B. Seitz

Summary of Facts and Submissions

I. The interlocutory decision of the Opposition Division on the amended form in which the European patent No. 0 193 591 (based on application No. 85 904 653.4) could be maintained was dispatched on 23 April 1991. On 8 June 1991 the Appellant (Opponent) filed an appeal against this decision, the appeal fee was paid on the same day and the Statement of Grounds of Appeal was received on 24 August 1991.

II. Oral proceedings were held on 18 May 1994 during which the Respondent (Proprietor) submitted an amended Claim 1 reading as follows:

"A piston for an internal combustion engine of the kind comprising a crown (10), a piston axis (28), a ring band (11) extending around the crown, gudgeon pin bosses (12a, 12b) supporting the crown and defining a gudgeon pin bore having an axis, and a skirt formed by two pairs of arcuate skirt portions (22) on opposite sides of the gudgeon pin bore and supported by struts (21a, 21b, 21c, 21d), each pair of arcuate skirt portions (23) including upper and lower arcuate skirt portions (22) disposed about a plane including the piston axis and normal to the gudgeon pin bore axis and extending only partially around the piston, the upper arcuate skirt portions (22) being spaced from the ring band (11) by an axially and circumferentially extending gap (25), said struts being formed by four struts extending from each gudgeon pin boss (12a, 12b), two (21a, 21b) of each said four struts extending upwardly and outwardly of, and from opposite sides of, the associated gudgeon pin boss (12a, 12b) and being connected to respective upper arcuate skirt portions (22a), the two remaining struts (21c, 21d) of each said struts extending downwardly and outwardly of, and from opposite sides of, the associated gudgeon pin

boss (12a, 12b) and being connected to respective lower arcuate skirt portions (22b), the lower arcuate skirt portions (22b) being spaced from associated upper arcuate skirt portions (22a) by an axially and circumferentially extending gap (25) and the arcuate skirt portions being conformable to adapt to the cross-sectional shape of an associated cylinder or liner, each arcuate skirt portion having upper and lower edges (23, 24) each lying in a respective plane normal to the piston axis (28) wherein each arcuate skirt portion has side edges (26) interconnecting said upper and lower edges with said side edges lying in respective planes including the piston axis (28) so that the gap (25) between the ring band (11) and each at least one upper arcuate skirt portion (22a) and the gap (25) between each at least one upper arcuate skirt portion and the associated at least one lower arcuate skirt portion is of constant width in a direction parallel to the piston axis."

III. In the appeal proceedings the Appellant relied on the following documents:

- D1: US-A-2 032 849;
- D2: DE-A-1 450 320;
- D3: US-A-1 774 396;
- D4: DD-A-74 992;
- D5: DE-A-2 625 191;
- D6: GB-A-720 172;
- D7: GB-A-266 343; and
- D8: US-A-2 066 613.

The Appellant argued that it was obvious to modify the piston according to document D1 in the way shown in an Annex A (accompanying the Statement of Grounds of Appeal) for a piston with set back gudgeon pin bosses to

arrive at a piston satisfying Claim 1. Set back gudgeon pin bosses were common in the state of the art as evidenced by documents D2 to D8.

He continued that the primary teaching of document D1 was not to make the piston running surfaces as long circumferentially as possible but solely to provide a larger guidance area than that achieved by a closed piston surface. A distorted shaft only contacted the cylinder running surface at small areas whereas a larger effective support surface could easily be achieved with a shaft which was flexible by means of struts. Document D1 did not exclude pistons with set back gudgeon pin bosses in which the circumferential area of the struts forming the shaft areas could readily be less than the maximum possible.

He concluded that thus it was obvious for the skilled person to make the side edges of the plate shaped running surfaces parallel to the piston axis, especially when the gudgeon pin bosses were already set back.

IV. The Respondent (Proprietor) argued that the Appellant's submissions were based on hindsight, that the modification to the piston of document D1 was not possible, would contradict the central teaching of the prior art document itself and anyway would not yield the claimed invention.

He saw the prior art document closest to the invention as being not document D1 but document D6.

V. The Appellant requests that the decision under appeal be set aside and that the patent be revoked.

The Respondent requests that the decision under appeal be set aside and that the patent be maintained in the version filed during the oral proceedings, namely:

- Claims: 1 to 4;
- Description: column 1, lines 3 to 27;
pages 2, 2a and 2b;
column 2, lines 19 to 65;
column 3; and
column 4, lines 1 to 17; and
- Drawings: sheets 1 and 2.

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*

The Board is satisfied that there are no objections under Article 123 EPC to the present version of the patent documents.

3. *Novelty*

After considering the documents brought forward in the appeal proceedings the Board concludes that none of them discloses a piston with all the features of the present Claim 1. Novelty was moreover not disputed by the parties.

4. *Comparison of documents D1 and D6 with the present invention*

4.1 The struts

In accordance with what is specified in Claim 1, each of the struts 21a-d shown in the drawings of the disputed patent clearly extends upwardly and outwardly, or downwardly and outwardly, of the respective gudgeon pin boss 12a, 12b to the respective arcuate skirt portion 22a, 22b. "Outwardly" in the context of the disputed patent means extending from a first point located inside the piston to a second point located further from the piston axis than is said first point.

Document D6 discloses a piston with arcuate skirt sections 20 supported by struts 21 joined to posts 10 receiving the gudgeon pin (see Claim 1 and Figures 3 and 4). Each strut 21 extends outwardly, that is from a line parallel to the piston axis and located nearer to the piston axis to a line on the inner surface of the skirt section which is located further away from the piston axis.

Document D1 discloses a double-X-web skirt 21 and web-connecting, arcuate skirt portions 22, 23, see Figure 1. The document can be construed that the areas between the gudgeon pin bosses 13 and the relief lines 16 are struts which support the arcuate skirt portions 22, 23 which commence at the relief lines 16. However while these struts extend upwardly or downwardly from the gudgeon pin bosses 13 to the relief lines 16 respectively, they do not extend outwardly since the whole of each strut is located at the same radial distance from the piston axis. While it could appear from Figure 1 of document D1 that the struts extend upwardly or downwardly and outwardly, in fact the struts

are extending upwardly or downwardly and **circumferentially**. Indeed the entire skirt including the X-webs and the web-connecting portions is of a strictly cylindrical form (see page 2, left hand column, lines 43 to 46 and page 1, right hand column, lines 13 to 15), so that it cannot be accepted that part of that cylindrical form, i.e. the relieved portion, extends outwardly in the meaning of the disputed patent.

Moreover while the struts 21a-d shown in the drawings of the disputed patent and the struts 21 disclosed by document D6 are clearly different components from the respective arcuate skirt portions they support, this is not the case with document D1 whose so-called struts and arcuate skirt portions are substantially one and the same because the struts are merely a very slightly reduced diameter portion of the skirt. Furthermore, document D1 does not use the term struts for these areas, in contrast to its use for the true struts numbered 11 and 18 joining the gudgeon pin bosses to respectively the piston head 8 and the thrust plate 17.

4.2 The arcuate skirt portions and the gaps

The definitions in Claim 1 are such that the arcuate skirt portions are segments of cylinders and have upper and lower edges running in horizontal planes, these upper and lower edges being connected by side edges which lie in planes including the piston axis. Thus constant width gaps are produced between the ring band and the respective arcuate skirt portion as well as between the arcuate skirt portions.

It can be seen from Figure 1 of document D1 that the upper and lower edges of these arcuate skirt portions 22, 23 are not interconnected by side edges which lie in planes including the piston axis and that

neither the gaps between the ring band and the upper arcuate skirt portions nor the gaps between the upper and lower arcuate skirt portions are of constant width in a direction parallel to the piston axis.

The piston of document D6 with its skirt sections 20 and gap 22 is thus more similar to the arrangement defined in Claim 1 than is the piston of document D1.

4.3 Conformability

It is explained in column 3, lines 38 to 42 of the disputed patent that the limited arcuate extent of the arcuate skirt portions and their spaced support on the struts allow the arcuate skirt portions readily to adapt to the cross-sectional shape of the cylinder or liner.

Similarly, in the piston of document D6, the relatively stiff resiliently flexible struts (see page 5, line 128) are connected to skirt sections which are flexible so that they maintain substantially full engagement with the cylinder wall when expanded by heat (see page 2, lines 107 to 111).

On the other hand, looking at document D1, the integrally connected X-webs 21 and web-connecting portions 22, 23 cooperating in forming the strictly cylindrical double-X-web skirt 14 (see page 2, left hand column, lines 43 to 46) and the relief of merely some five-thousandths of an inch around the pin bosses (see page 2, left hand column, lines 11 to 14) suggest a less flexible arrangement. This is borne out by the statements that during expansion of the skirt its cylindrical form is not varied (see page 1, right hand column, lines 38, 39) and that the skirt maintains its cylindrical form under all operating conditions (see page 2, left hand column, lines 14, 15) as well as by

the presence of triangular shaped ribs on the interior surfaces of the arcuate skirt portions (see Figure 3). The teaching of document D1 is not the provision of a flexible piston but the provision of a shape including the double-X-web to minimise the effects of expansion by maximising the lengthwise component of this expansion (see page 1, right hand column, lines 29-34), thereby maintaining the cylindrical form under all conditions. This maintenance of the cylindrical form is basically different to the provision of flexibility in the pistons according to document D6 and the present invention.

5. *Closest prior art, problem and solution*

5.1 Taking account of the comparisons in section 4 above concerning the struts, the shape of the arcuate skirt sections, the gaps and the conformability, the Board concludes that it is the piston according to document D6 rather than that according to document D1 which represents the prior art closest to the present invention. The maintenance of the cylindrical form of the piston according to document D1 under all conditions is basically different to the provision of flexibility in the pistons according to document D6 and the present invention.

The argument of the Appellant that it is common knowledge that a piston has to be flexible to adapt itself to an oval form does not take into account the precise and clear teaching in document D1 which might be explained by the fact that the document D1 originated in 1934.

5.2 The piston defined in Claim 1 differs from that known from document D6 essentially by

- each of the skirt sections 20 of the known piston being replaced by two skirt sections, one above the other and with a constant width gap therebetween; and
- each of the two struts 21 of the known piston being replaced by two struts extending respectively upwardly and downwardly.

5.3 The problem to be solved when starting from the piston according to document D6 can be seen as being to improve the piston construction and the Board is satisfied that this problem can be solved by the differences expressed in Claim 1 over the piston known from document D6. The inventive piston can weigh less due to the absence of the central zones of the known skirt sections and the struts of the inventive piston can also be lighter than the known struts 21 extending continuously from well below to well above the gudgeon pin openings 14. The conformability of the piston to the cylinder wall is also improved by the provision of four smaller arcuate skirt portions instead of two and by the provision of four smaller struts instead of two which furthermore extend in different directions i.e. upwardly and downwardly. The reduction in size of the lubricated area by omission of the central zone reduces the oil film frictional forces. To specify precise dimensions for the axial and circumferential extent would limit the scope of protection beyond that justified by the contribution to the state of the art.

6. *Inventive step starting from the closest prior art*

6.1 Documents D2 to D5, D7 and D8 do not teach a person skilled in the art either explicitly or implicitly to use skirt portions and struts as presently claimed so that he cannot be guided by them to the claimed solution in order to obtain the desired effects.

6.2 When starting from the closest prior art, namely the piston disclosed by document D6, the Board does not consider that the teaching of document D1 would lead the skilled person to modify the piston known from document D6 in such a way as to arrive at the piston defined in Claim 1. Indeed in addition to document D1 firstly being rather old, secondly going in the direction of a rather stiff piston construction and thirdly proposing a specific double-X-web skirt, the Board does not consider that the skilled person would (as opposed to merely could) follow the teaching of document D1 in such a way as to omit the central recessed zone 28 of each skirt section in the piston of document D6 since one of the purposes of the recessed zone described in page 4, lines 21-25 is to maintain a film of oil on the cylinder wall. Furthermore, even though the recessed zone might be considered as optional since it is not mentioned in the claims until dependent Claim 4, it must be remembered that its omission would merely result in a skirt section of uniform diameter, the same length as the existing skirt section 26-28 and continuous in the axial direction rather than resulting in a piston having a gap between the end zones as required by the present Claim 1. Indeed there is no single prior art document which sets out the advantages of such a kind of modifications, whereas document D1 suggests the use of a double-X-web skirt.

6.3 Even if each skirt section of the piston known from document D6 were split into two sections with a gap therebetween, it is not certain that the strut arrangement defined in the present Claim 1 would be chosen by the skilled person. He might decide to retain the specific existing struts which are so formed as to provide radial yieldability at their junctures with the skirt sections, namely struts having a substantially flat outer portion disposed substantially parallel to the wrist pin axis, and a curved inner portion (see document D6, page 2, line 119 to page 3, line 14).

7. *Inventive step if one were to start from the piston according to document D1*

7.1 The Appellant argues that document D1 is the closest prior art, in particular because it discloses **four** arcuate skirt portions (unlike various other documents which disclose pistons with only **two** arcuate skirt portions).

The wording of the present Claim 1 concerning the upper, lower and side edges of the arcuate skirt portions makes it clear that the present skirt portions are segments of a cylinder rather than having the shape according to document D1 with upwardly or downwardly directed extensions going towards the relief lines 16 (X-web skirt). This wording thus does not define an arbitrary difference and moreover necessitates a differently constructed connection of the arcuate skirt portions to the struts compared to that known from document D1.

7.2 Even if, against the finding of the Board set out in section 5.1 above, the skilled person were to take the piston according to document D1 as the starting point,

then the Board still could not see it as obvious for the skilled person to modify it in such a way as to arrive at the subject-matter of Claim 1.

- 7.2.1 Annex A submitted by the Appellant shows Figure 1 of document D1 modified in such a way as to satisfy Claim 1. The Appellant considers it obvious to move the relief line 16 bordering the struts and the arcuate skirt portions when modifying the piston known from document D1 to have set back gudgeon pin bosses, the latter being common in the state of the art as evidenced by documents D2 to D8.

However, line 16 is generated by relieving the cylindrical piston around the gudgeon pin bosses by merely five-thousandths of an inch (see document D1, page 2, left hand column, lines 11 to 15). Significant machining around the gudgeon pin bosses in an attempt to achieve side edges lying in planes including the piston axis, as defined in Claim 1, would remove the X-webs and thus the support for the arcuate skirt portions entirely. While it is clear in principle that a reduction in the diameter at the gudgeon pin bosses will result in a reduction of weight of the piston there is no hint in document D1 to do this; the teaching of the document is to achieve and maintain a cylindrical shape with merely very slight relief around the gudgeon pin bosses which would prevent jamming against the cylinder in these areas due to the increased expansion of these areas compared to the remainder of the skirt caused by the gudgeon pin boss areas containing more metal than the skirt.

- 7.2.2 The Appellant argues that document D1 teaches not guidance on the longest possible circumference but solely a larger guidance area than that achieved by a closed piston surface. A distorted skirt only contacts

the cylinder running surface at small areas whereas a larger effective support surface can easily be achieved with a skirt which is flexible by means of struts. Thus he maintains that document D1 does not exclude pistons with set back gudgeon pin bosses in which the circumferential area of the struts forming the shaft areas can readily be less than the maximum possible so that the side edges of the plate shaped running surfaces can be parallel to the piston axis.

However the Board sees document D1 as clearly teaching maximum contact (see page 1, right hand column, lines 16 and 17 - "more surface contact with the cylinder than a conventional piston") by its truly cylindrical shape which is maintained under all operating conditions (see page 2, left hand column, lines 11 to 15). Accordingly the skirt does not flex, especially in view of the reinforcing ribs. There is no justification for arguing that the shaft is flexible by means of the struts since the arcuate skirt portions are merely a continuation of the struts which, being merely relieved by five-thousandths of an inch, are of virtually identical thickness to the arcuate skirt portions. The Board sees no hint in document D1 itself or in the other available documents either towards making the skirt portions have straight upper and lower edges lying in planes normal to the piston axis or to making the side edges parallel to the piston axis.

- 7.2.3 Still further, since the piston according to document D1 has more surface contact with the cylinder than a conventional piston, is truly cylindrical and retains its cylindrical form under all operating conditions, its conformability to the cylinder wall is inferior to that of the piston of Claim 1 and so the problem solved by the invention is not solved by the piston according to document D1.

- 7.3 The Appellant mentions the documents D2 to D5, D7 and D8 in the appeal as evidence that set back gudgeon pin bosses are common in the art. The Board does not dispute this statement but sees nothing in these documents concerning four-skirted pistons and which would lead the skilled person to modify the piston of document D1 to arrive at the present invention.
8. The subject-matter of the present Claim 1 thus involves an inventive step in the meaning of Article 56 EPC.
9. The patent may therefore be maintained amended based on this independent claim, dependent Claims 2 to 4 which concern preferred embodiments of the piston according to Claim 1, the amended description and the drawings. The Board considers it appropriate in this specific case to define the subject-matter of Claim 1 in a one-part form since to divide the claim using the disclosure of document D6 would necessitate changes in wording which would make the claim more difficult to understand.
10. A communication under Rule 58(4) EPC is unnecessary in the present case (see decision T 219/83, OJ EPO 1986, 211) since the oral proceedings gave the parties adequate opportunity to comment therein on the present set of amended patent documents i.e. on the proposal to maintain the European patent in amended form.

Order

For these reasons, it is decided that:

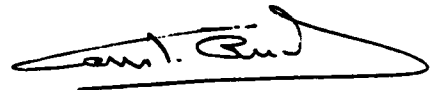
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent in the version filed during the oral proceedings (see above section V).

The Registrar:



N. Maslin

The Chairman:



C. Andries