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D E C I S I O N
of 10 September 1996

Case Number: T 0222/94 - 3.2.4

Application Number: 90904897.7

Publication Number: 0465500

IPC: F02B 33/14

Language of the proceedings: EN

Title of invention:
Stepped piston engine

Applicant:
HOOPER, Bernard

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56, 123(2)

Keyword:
"Extension of subject-matter (no)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0222/94 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 10 September 1996

Appellant: HOOPER, Bernard
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Decision under appeal: Decision of the Examining Division of the European Patent Office posted 2 November 1993 refusing European patent application No. 90 904 897.7 pursuant to Article 97(1) EPC.

Composition of the Board:

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

Summary of Facts and Submissions

I. On 10 January 1994 the appellant (applicant) lodged an appeal against the decision of the examining division dispatched on 2 November 1993 to refuse the European patent application No. 90 904 897.7 (International application No. PCT/GB90/00410, International publication No. WO-A-90/11436). The appeal fee was paid simultaneously and the statement of grounds of appeal was received on 7 March 1994.

II. The following prior art documents are referred to:

D1: DE-C-249 961
D2: US-A-4 781 153
D3: DE-C-398 900
D4: US-A-4 522 163
D5: US-A-4 630 591

III. The reasons given in the examining division's decision were extension of subject-matter by claim 5 filed with the letter of 24 May 1993 (Article 123(2) EPC) and lack of inventive step of claim 1 filed with the letter of 24 May 1993 (Articles 52(1) and 56 EPC).

Following a communication from the board the appellant submitted amended patent application documents with his letter of 12 June 1996.

IV. Claim 1 of the main request reads as follows:

—"~~A~~ stepped ~~p~~iston engine comprising ~~f~~irst (10), second (11) and third (12) stepped cylinders, each cylinder having a larger diameter pumping part (10p,11p,12p), and a smaller diameter working part (10w,11w,12w) and a piston (13,14,15) slidable in the cylinder (10,11,12),

each piston (13,14,15) being coupled to an output shaft (16) of the engine, first transfer passage means (20) to transfer pre-compressed charge from the larger diameter pumping part (10p) of the first cylinder (10) to the smaller diameter working part (11w) of the second cylinder (11), second transfer passage means (21) to transfer pre-compressed charge from the larger diameter pumping part (11p) of the second cylinder (11) to the smaller diameter working part (12w) of the third cylinder (12), and third transfer passage means (22) to transfer pre-compressed charge from the larger diameter pumping part (12p) of the third cylinder (12) to the smaller diameter working part (10w) of the first cylinder (10), characterised in that the first, second and third transfer passage means (20,21,22) have volumes within a variation of 25% of each other and each of the first, second and third transfer passage means (20,21,22) comprises an inlet passage part (20i;21i;22i;) which extends from the respective larger diameter pumping part (10p,11p, 12p) to a main passage part (20m,21m,22m) from which a pair of branches (20a,20b;21a,21b;22a,22b) extend, each branch communicating with the respective smaller diameter working part (11w,12w,10w) the combined lengths of the main passage part (20m;21m,22m), the branches (20a,20b;21a,21b;22a,22b) and the inlet passage part (20i;21i;22i) for each of the transfer passage means (20;21;22) being generally equal, the first, second and third cylinders (10,11,12) being arranged in this order generally in line with their respective cylinder axes contained or substantially contained within a common plane, the main passage part (22m) of the third transfer passage means (22) running closer to the cylinders (10,11,12) than the main passage parts (20m,21m) of each of the first and second transfer passage means (20,21)

do, so that the main passage part of the third transfer passage means is located between, on the one hand, the cylinders, and on the other hand the main passage parts of each of the first and second transfer passage means."

V. The appellant's **main request** is that the decision of the examining division be set aside and that a patent be granted on the basis of:

claims: claims 1 to 9 filed with the appellant's letter of 12 June 1996

description: pages 1 to 9 filed with the appellant's letter of 12 June 1996

drawings: sheets 1/3 to 3/3 of the International publication No. WO-A-90/11436.

The appellant's remaining **auxiliary requests** are for the grant of a patent on the basis of the documents titled "Third Amended Specification and Claims" filed with the statement of grounds of appeal, or remittal to the examining division for further examination, or oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments - main request*

2.1 All of the original claim 1 (ie that published with the International publication No. WO-A-90/11436) is present in claim 1 of the main request.

Claim 1 of the main request is derivable as follows:

- precharacterising portion: original claim 1
- the rest of lines 13 and 14: original claim 2
- lines 15 to 19: original claim 5
- line 19 to "equal" in line 22 - original page 5, lines 30 to 32 and also see page 5, line 34 to page 6, line 5
- from "the first" in line 22 to "plane" in line 25 - original claim 7
- from "the main" in line 25 to "do" in line 27 - original claim 10
- from "so" in line 27 to the end of the claim - from Figures 2 and 3.

2.2 Claims 2 to 4 of the main request are derived from the original claims 3, 4 and 6 respectively.

2.3 Claim 5 of the main request replaces the claim that was objected to by the examining division under Article 123(2) EPC, namely claim 5 filed with the letter of 24 May 1993.

This new claim 5 (appendant to any one of claims 1 to 4) has the same wording as the original claim 9 (appendant to claim 8 when appendant to claim 5).

The original claim 8 specified a reduced average cross sectional area for the third transfer passage means compared with the first and second transfer passage means such that their volumes were within 25% of each

other. While the result that the volumes are to be within 25% of each other is to be found in lines 13 and 14 of claim 1 of the present main request, it is not stated in said claim that this is to be achieved by different cross sectional areas. However it is clear from the original page 5, line 34 to page 6, line 5 that generally equal volumes of the transfer passage means are achievable not only by having different cross sectional areas. The whole of the original claim 5 is included in claim 1 of the main request.

Thus the essential parts of the original claim 9 are contained in claim 5 of the main request and there is no objection under Article 123(2) EPC thereto.

2.4 Claim 6 of the main request is derived from the original claims 11 and 12; claims 7 and 8 of the main request from the original claims 13 and 17 respectively; and claim 9 of the main request from the original claims 18 and 19.

2.5 The description for the main request consists of the originally filed description from which passages have been deleted or brought into line with the claims and an acknowledgement of the prior art added.

2.6 The drawings are those as originally filed.

2.7 There is thus no objection under Article 123(2) EPC to the present version of the application for the main request.

3. *Novelty - main request*

The combination of features specified in claim 1 of the main request is not disclosed by any of the prior art documents available to the board.

Document D3 only discloses the precharacterising portion of the claim.

The only other three cylinder engine document is D1. However if its cylinders are notionally numbered first, second and third from the left in Figure 3 (see lines 22 and 23 of claim 1 of the main request), then it can be seen that the interconnections 1-k from the larger diameter pumping part to the smaller diameter working part are from the first to the third cylinder, from the second to the first cylinder and from the third to the second cylinder, thus differing from the requirements of lines 5 to 13 of the claim.

Therefore even for these reasons the subject-matter of claim 1 of the main request is considered novel within the meaning of Article 54 EPC.

4. *Closest prior art - main request*

4.1 The closest prior art document is document D3 which discloses passages connecting stepped cylinders A and C, C and B, and B and A respectively.

4.2 This three cylinder engine is a better starting point than the two cylinder engine disclosed by document D2 because to transform a two cylinder engine into a three cylinder engine would involve radical changes.

4.3 While document D1 also discloses a three, stepped cylinder engine with interconnecting tubes r^1-r^3 which appear from Figure 3 to have approximately the same length, its cylinder order and interconnections do not match the basic configuration of the claimed engine (see section 3 above). Accordingly document D1 is a less suitable starting point than document D3.

5. *Problem and solution - main request*

5.1 It is apparent from a consideration of the layout of the cylinders of an in-line three cylinder engine that the distance between the axes of the end cylinders must be twice the distance between the axes of adjacent cylinders. It follows, and moreover can be seen easily from the Figure of document D3, that the passage connecting the larger diameter pumping part of the end cylinder A to the smaller diameter working part of the end cylinder C must be very much longer than the corresponding passage connecting the adjacent cylinders C and B, and B and A.

Thus because the Figure apparently shows the same cross sectional areas for the passages, the passage A-C has a much greater volume than the passages C-B and B-A.

5.2 This difference in volume clearly leads to variations of charge due to the different transfer times of the air masses leading to different amounts of air being available at the same point in different cylinder cycles, resulting in rough engine operation.

5.3 The problem is to avoid this rough engine operation while preserving compactness of the engine.

5.4 Claim 1 of the main request explains that the volumes of the transfer passage means are within 25% of each other (to solve the rough engine operation part of the problem) and that this is achieved by routing the main passage part of the third transfer passage means closer to the cylinders than the other two main passage parts are. The result is to bring the lengths of the three transfer passage means into general equality in an economic way with respect to compactness of the engine and the length of each transfer passage means. The inlet part and branches of the third transfer passage means can be shorter than the corresponding parts of the other transfer passage means. While, to bring them to the length of the third transfer passage means, the first and second transfer passage means are longer than the minimum necessary to link the respective cylinders, they are not as long as they would have been if the third transfer passage means had been less advantageously routed.

5.5 Thus the board considers that the problem is solved by the features of claim 1 of the main request.

6. *Inventive step - main request*

6.1 In the three cylinder engine disclosed by the closest prior art document D3, the passages interconnecting the cylinders A, B and C consist of inlet and outlet passage parts with a main passage part therebetween. Each passage has a single outlet passage part. Claim 1 of the main request on the other hand specifies that each ~~passage means has a pair of branches~~ communicating with the smaller diameter working part of the cylinder but the board does not see this as inventive because branches are well known for efficient scavenging, eg from document D2.

6.2 As stated in section 5.1 above, the passage connecting the end cylinders A and C of the engine according to document D3 has a much greater volume than that of the passages connecting the adjacent cylinders C and B, and B and A. Engine design has changed considerably since the 1920's when the document D3 originated. More sophisticated fluid flow considerations enable modern day engines to be more efficient and smoother running. The skilled person would notice the poorer running of the prior art engine compared with modern day engines and would realise a cause was that different amounts of air were being made available at the same point in different cylinder cycles because of the different volume of the passages interconnecting the cylinders.

In his search to avoid rough engine operation, the skilled person might make the volumes of the transfer passages the same, by reducing the cross sectional area of the third passage. However the three passages then would still have different flow characteristics.

One obvious possibility for the skilled person would then be to keep the cross sectional areas of the three transfer passages the same but make them of generally equal length thus achieving both equal volumes and similar flow characteristics for each passage.

Such an obvious arrangement would however mean making the first and second passages longer than otherwise necessary so that the engine would be less compact.

6.3 The present invention overcomes also this disadvantage in what the board considers to be a non-obvious way. The locations of the three transfer passage means are chosen in such a way as to bring their lengths into general equality in an economic way with respect to compactness of the engine and the length of each transfer passage

means. Claim 1 of the main request specifies that the main passage part 22m of the third transfer passage means 22 runs closer to the cylinders 10,11,12 than the main passage parts 20m,21m of each of the first and second transfer passage means 20,21 do, so that the main passage part of the third transfer passage means is located between, on the one hand, the cylinders, and, on the other hand, the main passage parts of each of the first and second transfer passage means.

As explained in section 5.4 above, the inlet part and branches of the third transfer passage means can then be shorter than the corresponding parts of the other transfer passage means. While, to bring them to the length of the third transfer passage means, the first and second transfer passage means are longer than the minimum necessary to link the respective cylinders, they are not as long as they would have been if the third transfer passage means had been less advantageously routed.

6.4 Document D3 contains no hint towards the particular locations of the transfer passage means set out in claim 1 of the main request.

6.5 Document D1, either as a starting point or an additional teaching to that of document D3, gives the skilled person no help in arriving at an engine according to claim 1 of the main request. The distributing tubes of the engine connecting the stepped cylinders according to document D1 do so in a different order to that defined ~~in~~ claim 1 ~~of~~ the main request. Moreover it can be seen from Figure 1 that the transfer passages r^1-r^3 are arranged equidistantly from the cylinders.

6.6 It is clear from the configuration of a two, stepped cylinder engine that no rough running problem can arise from the different lengths of the cylinder interconnecting passages because the passage connecting the larger diameter pumping part of the first cylinder to the smaller diameter working part of the second cylinder can be expected to have the same length as the corresponding passage from the second cylinder to the first cylinder. Accordingly documents such as documents D2 and D5 dealing with two cylinder engines will be of no help to the skilled person in solving a problem occurring with engines with more than two cylinders.

6.7 Document D4, concerning the lubrication of a stepped piston, is irrelevant to the problem facing the skilled person starting from document D3.

6.8 The board cannot see that any combination of the documents available to it, even if one assumes that actually making such a combination is obvious, would lead to the subject-matter of claim 1 of the main request.

7. The subject-matter of claim 1 of the main request is thus patentable as required by Article 52 EPC. A patent may therefore be granted based on this allowable independent claim and on claims 2 to 9 which are dependent on claim 1.

The appellant's **auxiliary requests** therefore have no effect.

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 in the following version:

claims: claims 1 to 9 filed with the appellant's letter of 12 June 1996

description: pages 1 to 9 filed with the appellant's letter of 12 June 1996

drawings: sheets 1/3 to 3/3 of the International publication No. WO-A-90/11436.

The Registrar:

N. Maslin

The Chairman:

C. Andries