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File Number: T 559/90 - 3.2.4  
Application No.: 86 107 641.2  
Publication No.: 0 205 103  
Title of invention: Rotor assembly of roots pump

Classification: F04C 18/18

D E C I S I O N  
of 2 October 1992

Applicant: TOYOTA JIDOSHA KABUSHIKI KAISHA

Headword:

EPC Art. 56

Keyword: "Inventive step (yes)"



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Boards of Appeal

Chambres de recours

Case Number : T 559/90 - 3.2.4

**DECISION**  
of the Technical Board of Appeal 3.2.4  
of 2 October 1992

**Appellant :** TOYOTA JIDOSHA KABUSHIKI KAISHA  
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**Decision under appeal :** Decision of Examining Division of the European  
Patent Office dated 26 January 1990 and  
dispatched on 12 March 1990 refusing European  
patent application No. 86 107 641.2 pursuant to  
Article 97(1) EPC.

**Composition of the Board :**

**Chairman :** C.A.J. Andries  
**Members :** P. Petti  
M.V.E. Lewenton

### Summary of Facts and Submissions

I. European patent application No. 86 107 641.2, filed on 5 June 1986, was refused by a decision of Examining Division 2.3.11.104 given at the end of the oral proceedings on 26 January 1990, the reasons for the decision being dispatched on 12 March 1990.

II. The reason for the refusal was that the subject-matter of Claim 1 lacked an inventive step having regard to documents:

D1: EP-A-135 257

D2: US-A-3 275 225.

III. On 9 May 1990 a notice of appeal was filed against this decision and the prescribed fee was paid. A written statement setting out the grounds of appeal was filed on 22 June 1990. The Appellant requested the cancellation of the decision and the grant of a patent on the basis of Claim 1 as submitted during the oral proceedings held before the Examining Division.

IV. In response to a communication of the Board the Appellant filed with his letter of 3 September 1992 amended Claims 1 and 5 and amended pages 1a, 3, 8 and 16 of the description. He requested the grant of a patent on the basis of these documents together with Claims 2 to 4 as filed with letter of 30 January 1989, pages 1, 2, 4 to 7, 9 to 15 of the description as submitted during the oral proceedings held before the Examining Division on 26 January 1990 and the drawings as originally filed.

Minor amendments to these documents were agreed between the Appellant and the Rapporteur of the Board in a

telephone conversation on 18 September 1992. These amendments concern Claims 1 and 4, page 1 of the description and the re-introduction of page 6 of the description as originally filed instead of page 6 as submitted during the oral proceedings held before the Examining Division on 26 January 1990.

V. Independent Claim 1 as amended is worded as follows:

"A Roots pump having a plurality of rotor assemblies (17, 18) each of which includes a rotor made of light alloy having an axial bore (20, 42) formed therethrough, a support shaft (14) made of steel which has a timing gear (11, 12) fixed to one of opposite axial ends thereof and which is press-fitted in the axial bore (20) to support a rotor, wherein said shaft (14) has a plurality of engagement teeth (22) provided at one of opposite ends of said press-fitted portion on the side of said timing gear (11, 12), said engagement teeth (22) being spaced from each other in a circumferential direction and at least partially embedded in an inner surface (42) defining said axial bore of the rotor, upon press-fitting of said press-fitted portion in said axial bore, to thereby prevent a rotational movement of said shaft relative to said rotor, characterized by a lock pin (26) which is inserted through the rotor (18) and the shaft (14) in a direction intersecting an axis of rotation of the rotor assembly to prevent removing of the shaft from the rotor; wherein said lock pin (26) is located substantially at an axial center of a press-fitted portion of said shaft (14) which is accommodated in said axial bore (20) and wherein the press-fitted portion has a length which substantially corresponds to the whole length of the axial bore (20, 42) of the rotor, such that the axial displacement of the rotor takes place evenly on both sides of the lock pin (26)."

Reasons for the Decision

1. Admissibility of the appeal

The appeal complies with Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. Allowability of amendments

2.1 The present Claim 1 combines the features of original Claims 1 and 2 with the feature that the press-fitted portion has a length which substantially corresponds to the whole length of the axial bore of the rotor such that the axial displacement of the rotor takes place evenly on both sides of the lock pin. This feature can be derived from the original drawings (particularly from Figure 2) and from the original description (particularly from page 6, lines 4 to 12).

2.2 Claims 2, 3 and 5 correspond to original Claims 4, 5 and 8 respectively, whereas Claim 4 corresponds to original Claim 7 and part of the original Claim 6.

2.3 The amendments made to the description concern their adaptation to the new claims and the reference to the prior art.

2.4 There are therefore no objections to the amendments under Article 123(2) EPC.

3. Novelty

The subject-matter of Claim 1 is novel within the meaning of Article 54 EPC, since there is no document available to the Board which discloses a Roots pump having a shaft

which is not only provided with engagement teeth but also connected to the rotor by an additional lock pin as defined in Claim 1.

4. Closest prior art

4.1 Document D1 is the only pre-published document available to the Board which discloses a Roots pump having a rotor made of light alloy and a shaft made of steel. Since the problem to be solved, as originally formulated, depends on the large difference in the thermal expansion co-efficient between rotor and shaft, the Board is of the view that this document reflects the closest prior art.

4.2 Neither document D2 nor the Japanese Patent Abstract (D3) corresponding to document JP-A-59-63 390 mentioned in the description of the application contains any information concerning the materials of the shaft and rotor.

The Roots pump referred to in the description of the application (page 1a, first paragraph) as unpublished internal state of the art is not to be considered as prior art according to Article 54 EPC.

5. Problem and solution

5.1 Document D1 refers explicitly to the difference in the expansion coefficient between the material of the rotor and that of the shaft, see page 12, lines 21 and 22. The rotor assembly according to document D1 has a stepped shaft which is press-fitted in an axial stepped bore of the rotor and provided with a plurality of engagement teeth which form mating splines in the rotor. When said shaft is pressed into said bore, two axially spaced apart interference fits are formed at the lateral regions of the assembly.

The shaft of the rotor assembly is described in document D1 as having a "shoulder 24d which ensures that growth differences between the shaft and the rotor are to the right of the shoulder", cf. page 8, lines 14 to 17.

Moreover, in this known Roots pump a bearing assembly 32 is provided with springs which "preload the rotor and shaft assembly to the right ..., thereby ... allowing the rotors and shafts to thermally expand or contract due to temperature changes", see page 14, lines 17 to 21.

The shoulder 24d and the bearing assembly 32 therefore ensure the axial positioning of the shaft with respect to the rotor.

Thus, document D1 deals with a technical problem relating to the difference in axial expansion between rotor and shaft and solves this problem by an arrangement in which the displacement of the rotor relative to the shaft takes place towards the right side away from the shoulder 24d.

5.2 The Roots pump according to Claim 1 differs from the prior art known from document D1 by the following groups of features:

(1) a lock pin is inserted through the rotor and the shaft in a direction intersecting an axis of rotation of the rotor assembly to prevent removal of the shaft from the rotor;

(2) the press-fitted portion has a length which substantially corresponds to the whole length of the axial bore,

(3) the lock pin is located substantially at an axial centre of a press-fitted portion of the shaft which is accommodated in the axial bore.

Due to the features of the first group, the axial positioning of the rotor and the shaft with respect to each other is easily achieved, i.e. without providing the shaft with a shoulder.

The features of the second and third group result in the effect defined in Claim 1 and described at page 6, lines 4 to 14 of the original description being achieved, namely that the axial displacement of the rotor -relative to the shaft - takes place evenly on both sides of the lock pin.

Moreover, the features of the third group contribute to increase the interference fit between rotor and shaft.

- 5.3 It follows that the problem to be solved can be seen as being to provide a Roots pump comprising a rotor assembly which ensures an easy axial positioning of the shaft with respect to the rotor and being to protect the rotor from high axial stresses due to the difference in the thermal expansion coefficients of rotor and shaft.

The Board is satisfied that this technical problem is solved by the combination of the features of Claim 1.

6. Inventive step

- 6.1 Document D2 discloses a Roots pump in which the rotor is connected to the shaft by means of a locking pin located substantially at the axial centre of the shaft which is accommodated in the axial bore of the rotor. However, the portion of the shaft in which the pin is arranged is not a press-fit portion.



Document D2 does not explicitly disclose any link with the technical problem to be solved, particularly with that aspect of the problem which concerns the protection of the rotor from axial stress due to different thermal expansion between rotor and shaft. Such a link cannot even be considered as implicitly suggested in document D2 since this document does not even relate to a rotor and a shaft made of materials having different expansion coefficients.

The person skilled in the art, therefore, could not be guided by document D2 to the claimed solution.

6.1.1 Moreover, it is unlikely that a skilled person would try to apply an additional locking pin to the rotor assembly according to document D1, because he would then lose the advantage of reduced assembly costs (see document D1, page 13, lines 11 to 15: "the shafts may be pressed in the rotor bores without concern of angular phasing or timing between the shafts and their associated rotors...").

In any case, even if the skilled person were to apply the features known from document D2 to a Roots pump according to document D1, he still would not arrive at the subject-matter of Claim 1. He would still need to carry out a further step of modifying the pump according to document D1, namely to locate the pin in a press-fitted portion which extends over the whole length of the axial bore of the rotor. In order to make this further step, the skilled person would have to once again omit an essential feature contained in Claim 1 of document D1, namely the feature that the shaft includes at least two spaced apart press-fit portions.

However such an approach, which is not based on clear indications or suggestions in the documents concerned to the advantages to be expected, has to be considered as the consequence of an ex-post-facto analysis.

- 6.2 The other documents cited in the Search Report are further away from the subject-matter of Claim 1. None of these documents suggests how to protect the rotor from axial stresses due to the difference in the thermal expansion coefficients of rotor and shaft.
- 6.3 It follows that the subject-matter of Claim 1 involves an inventive step within the meaning of Article 56 EPC.
7. The subject-matter as set forth in Claim 1 is, therefore, patentable within the meaning of Article 52 EPC, so that a patent based on this allowable Claim 1, the dependent Claims 2 to 5, which concern particular embodiments of the pump according to Claim 1, the amended description and the originally filed Figures 1 to 6 may be granted.

#### Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.
2. The case is referred back to the Examining Division with the order to grant a patent on the basis of the following documents:

Claims: Claims 1 and 5 filed with letter of 3 September 1992 with the amendments to Claim 1 agreed by telephone on 18 September 1992;

Claims 2 to 4 filed with letter of 30 January 1989 with the amendments to Claim 4 agreed by telephone on 18 September 1992;

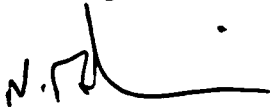
Description: Pages 1, 2, 4, 5, 7, 9 to 15 as submitted during the oral proceedings held before the Examining Division on 26 January 1990 with the amendments to page 1 agreed by telephone on 18 September 1992;

pages 1a, 3, 8 and 16 filed with letter of 3 September 1992;

page 6 as originally filed;

Drawings: Sheets 1 and 2 as originally filed.

The Registrar:



N. Maslin

The Chairman:



C. Andries

