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**D E C I S I O N**  
of 24 July 1998

**Case Number:** T 0059/97 - 3.2.4

**Application Number:** 91118912.4

**Publication Number:** 0486876

**IPC:** F01L 1/04

**Language of the proceedings:** EN

**Title of invention:**

Machine element with at least a fitting member pressure-fitted on a shaft

**Patentee:**

Nippon Piston Ring Co., Ltd.

**Opponent:**

Etablissement Supervis

**Headword:**

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**Relevant legal provisions:**

EPC Art. 54, 56

**Keyword:**

"Novelty - yes"  
"Inventive step - yes"

**Decisions cited:**

T 0300/89, T 0664/90

**Catchword:**

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## Summary of Facts and Submissions

- I. The decision of the opposition division to reject the opposition against European patent No. 0 486 876 was dispatched on 13 November 1996.

On 9 January 1997 the appellant (opponent) filed an appeal and the statement of grounds of appeal, and paid the appeal fee.

- II. The following documents were referred to during the appeal proceedings:

D2: DE-A-3 717 190

D5: US-A-2 279 954

D13: "Roloff/Matek Maschinenelemente", 10th edition  
1986, Friedr. Vieweg & Sohn, Braunschweig,  
page 379

D14: EP-A-0 190 841

- III. Oral proceedings took place on 24 July 1998 in the presence of the parties.

During these oral proceedings the respondent (patentee) filed a new claim 1 reading:

"A machine element comprising at least one fitting member (20) pressure-fitted on a shaft (10), the fitting member having a bore (25) for receiving the shaft, the shaft having at least an area (A) formed with protrusions (12) on which the fitting member is fitted, said protrusion of the shaft having an outer diameter (D1) larger than the outer diameter (D) of the shaft, the bore having an inner narrow portion (22) defining a space diametrically smaller than the protrusions, the protrusions (12) extending peripherally on the shaft (10), the bore (25) having at least one inner surface (22) having a perpendicular

from the center of the bore shorter than the radius of said protrusions, wherein the fitting member (20) is configured to be forced axially onto the protrusions of the shaft with at least one inner surface of the bore forming a corresponding outer surface on the protrusions (12), characterized in that said at least one inner surface of the bore is a chordal inner surface."

- IV. In the appeal proceedings the appellant argued that claim 1 relates to a finished product but that its components are defined only prior to assembly. Claim 1 in fact describes an impossible object and must be interpreted as a product-by-process claim, which means that those features which are distinguishable merely in the unassembled parts and not in the finished product must be disregarded. Therefore document D14 is novelty destroying. Claim 1 also lacks novelty or inventive step having regard to documents D2, D5 and D13.

In the appeal proceedings the respondent argued that the person skilled in the art could easily understand claim 1 which comprises the essential technical features with which he can work to arrive at the advantageous solution presently claimed. The prior art however contains no hint to lead the skilled person to the claimed subject-matter.

- V. The appellant requested that the decision under appeal be set aside and the patent revoked.

The respondent requested that the decision under appeal be set aside and the patent be maintained on the basis of claim 1 filed during the oral proceedings.

## Reasons for the Decision

1. The appeal is admissible.
2. *Amendment to claim 1*

The sole amendment to the granted claim 1, adding the word "axially" after "forced" in column 6, line 51 of the published patent specification, is based on lines 55 to 57 of column 4, lines 9 to 11 of column 5, and the arrows B in Figures 5 and 6.

3. *Interpretation of claim 1*

- 3.1 Claim 1 opens with the words "A machine element comprising at least one fitting member (20) pressure-fitted on a shaft (10)" and so gives the impression that what is claimed is an assembled, i.e. finished, article.

However, as the appellant points out, in this assembled condition, the claim would be wrong to say that the bore 25 of the fitting member 20 has an inner narrow portion 22 defining a space diametrically smaller than the protrusions on the shaft 10, since such a condition would be impossible.

The board considers that the claim is to be so interpreted as being directed to at least two parts, namely at least one fitting member and the shaft, and the instructions for assembling these parts. Thus the wording "fitting member (20) pressure-fitted on a shaft (10)" is to be understood as a "fitting member (20) to be pressure-fitted on a shaft (10)", particularly in view of the newly introduced wording "to be forced axially" in claim 1.

- 3.2 The words "said at least one inner surface of the bore is a chordal inner surface" in the characterising portion of claim 1 make it clear that that inner surface of the bore and the chordal inner surface are one and the same.

Moreover the proprietor stated firmly in the oral proceedings that if there were to be more than one inner surface (by this is meant a surface for deforming the shaft protrusions and which is different from the arcuate inner surfaces of the fitting member bore) then each of these inner surfaces would be a chordal inner surface and that projections (like those numbered 5 on Figure 2 of document D2 for cutting grooves 9 in the shaft protrusions as shown on Figure 9) were excluded.

- 3.3 A chord is defined as a straight line joining two points on a circle through the inner area of the circle (but not a diameter of the circle).

4. *Document D14 and novelty*

- 4.1 Figure 4 of D14 shows cam and journal elements 12, 14 with hexagonal openings 15 (see lines 1 and 2 of page 5), through which a tube 11 is passed (see lines 25 and 26 of page 5). As explained between page 5, line 29 and page 6, line 9, a mandrel 16 is then cold pressed through the inner diameter of the tube 11, causing it to expand and force the outer surface of the tube 11 into the hexagonal configuration of the openings 15 to form a mechanical bond between the tube and the surrounding components and result in the camshaft assembly 10 shown in Figures 1 to 3. D14 discloses (see Figure 4 and page 5, lines 4, 5 and 29

to 35) that, before assembly, the shaft is a hollow tube which has no protrusions. The parts of D14, before their assembly, are therefore different from the corresponding parts in the present claim 1 (see the above section 3.1).

4.2 Furthermore, it is undisputed that the manufacturing method of D14, involving **radial** expansion of the tube 11 into the element openings 15, is completely different to the method disclosed by the present patent specification where a fitting member 20 (analogous to the cam and journal elements 12, 14 of D14) is **axially** forced onto protrusions 12 on shaft 10.

4.3 However the appellant maintains that the novelty of a product cannot rely on its method of manufacture, that features which are distinguishable merely in the unassembled parts and not in the finished product must be disregarded, and that the finished machine element (e.g. camshaft assembly) of the present invention is indistinguishable from the finished camshaft assembly of D14. He cites decisions T 300/89 (an abridged version is in OJ EPO 1991, 480) and T 664/90 (not published in the OJ).

4.4 These cited decisions concern chemical products and optical fibres respectively, and the board can agree that it could indeed be impossible in these particular cases to distinguish the claimed articles per se from their prior art counterparts. However, especially in the mechanical field, the method of manufacturing a product often does leave its mark on the finished product. Thus, for example, it should be possible to decide whether a finished camshaft has been made by machining a one-piece cast blank or has been made by welding together separate parts.

4.5 In the present case the board sees at least one difference between the finished product of claim 1 and the finished product of D14, namely concerning the diameter of the shaft adjacent the fitting member.

It can be seen in Figure 5 of the present patent that the fitting member 20 is slid along the shaft 10 for the inner chordal surface 22 to deform the protrusions 12. This is expressed in the claim by the wording "the fitting member (20) is configured to be forced axially onto the protrusions of the shaft". To enable this axial sliding, the bore 25 of the fitting member 20 must be larger than the outside diameter D of the shaft (outside the fitting area i.e. excluding the area with the protrusions 12). Thus in the finished assembly, as shown by Figure 1, there will be a decrease in diameter from the bore of the fitting member to the adjacent shaft diameter.

On the other hand, Figure 3 of D14 shows, and lines 4 to 9 of page 6 explain, that portions of the tube 11 between the elements 12 and 14, after the tube has been inserted in the openings 15, are expanded beyond the diameter of the openings 15 so as to positively lock the elements in longitudinal relationship. Thus in the finished assembly, as shown by Figure 3, there will be a **increase** in diameter from the bore of the cam and journal elements 12, 14 to the adjacent tube diameter. This is in contrast to the present invention.

4.6 Further, the degree of filling of the fitting member bore by the deformed metal of the shaft can be investigated.



Figure 2 of D14 is a cross section of the finished camshaft assembly showing the whole of the outside surface of the tube 11 touching the whole of the inner surface of the hexagonal opening 15. This complete filling is a necessary result of the radially expanding action of the mandrel 16.

By contrast, Figure 2 of the present patent specification is a cross section of the finished camshaft assembly and shows gaps between the inner arcuate surfaces 21 of the cam piece 20 and the outside of the protrusion 12. It seems most unlikely that the protrusion dimensions would be exactly those needed to ensure exact filling of the bore of the fitting member upon deformation of the protrusions by the chordal inner surface or surfaces. At least, the appellant has not demonstrated that this would be the case.

4.7 Thus the board concludes that the machine elements of the present invention and D14 can be distinguished one from the other before or even after having been assembled (if necessary by cutting up the products), i.e. that the machine element of the present invention is novel over that of D14.

5. *Document D2 and novelty*

5.1 In D2 cams 2 are pushed axially along a camshaft 2 such that projections 5 in the cam bores 4 cut grooves 9 in camshaft protrusions C to hold the cams fast on the shaft (see column 3, line 47 to column 4, line 30, and Figures 1, 2 and 4 to 9).

5.2 It is not in dispute that D2 discloses the features of the precharacterising portion of claim 1.

The characterising portion adds merely that "said at least one inner surface of the bore is a chordal inner surface". In the written appeal proceedings the appellant argued that a chord implied a circle that however was undefined in the claim and that moreover the inner edge of the projection 5 constituted a chord of the circle of the bore 4.

- 5.3 The board considers however that it is clear that, in Figure 2 of the present patent, the circle in question is the circle of which the inner arcuate surfaces 21 form parts. In each possibility in Figure 10 it is clearly the circle connecting the points of the polygon. Moreover, as explained in the above section 3.3 a chord is defined as a straight line joining two points on a circle through the inner area of the circle (but not a diameter of the circle).
- 5.4 The inner edge of the projection 5 of D2 is thus only a part of a chord of the circle defining the bore 4. Since the inner edge is not a chord, the machine element of claim 1 is novel over D2.
- 5.5 On agreement of the respondent with this definition of a chord, the appellant agreed to drop the novelty objection based on D2.

6. *Novelty - conclusion*

The machine element of claim 1 has been shown in sections 4 and 5 above to differ from those of D14 and D2 respectively. None of the other prior art sources available to the board discloses the subject-matter of claim 1.

Therefore the subject-matter of claim 1 is considered novel within the meaning of Article 54 EPC.

7. *Closest prior art, problem and solution*

7.1 The parties and the board agree that the closest prior art is the camshaft assembly disclosed by D2. This camshaft assembly has some disadvantages, see the present patent, column 1, lines 45 to 54, namely that it is not easy to provide the projections in the bore of the fitting member on account of their shape. Also fitting member must be harder than the shaft, since the projections in the bore of the fitting member must cut grooves in the shaft protrusions, rather than being worn down or sheared off by the shaft protrusions.

7.2 Thus the problem underlying the present invention is to find a way around the difficulties associated with the camshaft assembly of D2.

7.3 The solution to this problem is that the (or each) inner surface of the bore having a perpendicular from the centre of the bore shorter than the radius of said protrusions is a chordal inner surface. It can be appreciated from Figure 2 that the central part of the chordal inner surface 22 affects the protrusions 12 of the shaft the most, if the fitting member is harder than the shaft then these central portions of the protrusions will be shaved off and if the fitting member and shaft are similar in hardness than these central portions will be plastically deformed. The side portions of the chordal inner surface will have less effect on the protrusions. Such a chordal surface is easier to form than a projection. Moreover, no longer is it necessary for the fitting member to be harder than the shaft.

7.4 The board thus considers that the problem set out in section 7.2 is solved by the features of the present claim 1, especially by the characterising feature.

8. *Inventive step*

- 8.1 The appellant argues that the only difference over the camshaft assembly disclosed by D2 is the widening of the projection in the bore of the fitting member and that this difference cannot be inventive, especially in view of the statement in column 3, lines 57 to 60 of D2 that other cross sectional forms for the projection are possible. The projection-groove connection of D2 provides the optimum security but, if less security can be accepted, then the projection-groove connection can be replaced by a polygonal connection e.g. by a 10 angled polygonal connection which the skilled person can see from Figure 10 of the present patent is the optimum polygonal connection.
- 8.2 The independent claims 1 and 9 of D2 each specify the projection-groove connection which is the central idea of this prior art document. To widen the projection to a chord would entail the loss of the groove in the shaft protrusions. Accordingly the skilled person would not just be making a minor change by omitting this particular connection but would be radically redesigning the camshaft. The board sees no hint in D2 that would lead him to do this.
- 8.3 Document D5 cannot lead the skilled person towards the present invention since the cylindrical socket 10 in the structure 9 comprises no chordal surfaces but merely arcuate fillets 11 adjacent essentially semi-circular grooves 11.
- 8.4 Document D13 concerns polygonal connections but is too general a teaching to help the skilled person in his search for a solution to the problem arising from the camshaft of D2. The connection seems to rely on wedging with no indication of removal of material from protrusions on the shaft.

8.5 As the appellant points out, hexagon socket spanners are known for fitting over hexagonally headed bolts while Allen keys are known for insertion into socket headed screws. In each case the hexagonal form ensures turning without slipping. However where a camshaft is concerned the cam must be permanently fixed not only rotationally but also longitudinally relative to the shaft, achieved in the present invention by the deformation of the shaft protrusions. This integrity in the axial direction is the opposite of the fastener situation where the tool must be able to be removed from the fastener after fastening without damage to either.

8.6 Thus the board sees no hint in the available published prior art and in common general knowledge that would lead the skilled person from the camshaft of D2 towards the solution set out in the present claim 1. To maintain that the patent itself would lead the skilled person in this direction can of course only be an ex post facto argument.

8.7 Thus the subject-matter of the present claim 1 is not obvious.

9. The subject-matter of claim 1 is patentable as required by Article 52 EPC. The patent may therefore be maintained with this independent claim and claims 2 to 8 which are dependent thereon.

**Order**

**For these reasons it is decided that:**

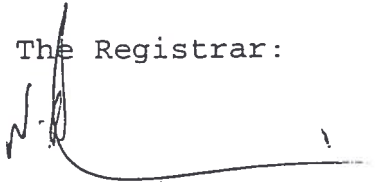
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent in the following version:

**Claims:** 1 filed during the oral proceedings  
2 to 8 as granted

**Description:** Columns 1 to 6 as granted


**Drawings:** Figures 1 to 10 as granted

The Registrar:



N. Maslin

The Chairman:



C. Andries