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**D E C I S I O N**  
**of 11 November 1993**

**Case Number:** T 0097/91 - 3.2.4

**Application Number:** 82305628.8

**Publication Number:** 0079156

**IPC:** F04C 2/10

**Language of the proceedings:** EN

**Title of invention:**  
Oil pump

**Patentee:**  
Sumitomo Electric Industries Limited

**Opponent:**  
Danfoss A/S

**Headword:**  
-

**Relevant legal norms:**  
EPC Art. 54, 56, 100(a), 100(b)

**Keyword:**  
"Sufficiency of disclosure (yes)"  
"Novelty (yes)"  
"Inventive step (yes)"

**Decisions cited:**  
T 0292/85, T 0226/85, T 0017/85

**Catchword:**  
-



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Boards of Appeal

Chambres de recours

Case Number: T 0097/91 - 3.2.4

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.4  
of 11 November 1993

**Appellant:**  
(Opponent)

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**Representative:**

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**Respondent:**  
(Proprietor of the patent)

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**Decision under appeal:**

**Decision of the Opposition Division of the  
European Patent Office dated 19 October 1990,  
posted on 26 November 1990 rejecting the  
opposition filed against European patent  
No. 0 079 156 pursuant to Article 102(2) EPC.**

**Composition of the Board:**

**Chairman:** C.A.J. Andries  
**Members:** P. Alting van Geusau  
J.-P.B. Seitz

**Summary of Facts and Submissions**

I. European patent No. 0 079 156 was granted with effect from 16 March 1988 on the basis of European patent application No. 82 305 628.8 filed on 22 October 1982.

Claim 1 of the patent reads as follows:

"An oil pump of the internal gear type incorporating an inner rotor intended to be directly connected to the crankshaft or to a transmission shaft of the internal combustion engine, said inner rotor being provided externally with gear teeth and located within a hollow outer rotor provided internally with gear teeth meshing with the external gear teeth of the inner rotor, the number of gear teeth on the outer rotor exceeding by one the number of gear teeth on the inner rotor, characterised in that the inner rotor is provided with  $n$  external gear teeth, the profile of said external teeth being generated by the locus of a point spaced at a distance  $e$  from the centre of a rolling circle of diameter  $B$  when said rolling circle rolls, without slipping, around the circumference of a base circle of a diameter  $A$  and an inside envelope curve formed by a plurality of circles of diameter  $C$  centred on the curve of said locus and determined by the values of  $A$ ,  $B$ ,  $C$  and  $e$  according to the following conditions:-

$$\frac{A}{B} = n \geq 8; \frac{C}{B} \text{ is } 0.5 \sim 3.0; \text{ and } \frac{e}{B} \text{ is } 0.4 \sim 0.5,$$

and in that the  $(n+1)$  internal teeth of the outer rotor have a profile including  $(n+1)$  arcuate portions of radius  $r$  equally spaced around the axis of the outer rotor and centred at a distance  $R$  from said axis to form  $(n+1)$  teeth directed towards said axis between

respective pairs of said (n+1) arcuate portions,  
wherein:

$$r = \left(\frac{C}{2} + \Delta r\right); \quad R = \left(\frac{A+B}{2} + \Delta R\right); \quad \Delta R > \Delta r."$$

II. With notice of opposition filed on 14 December 1988 the Appellant (Opponent) requested revocation of the patent for the reasons of non-compliance with the provisions of Article 100(a) and (b) EPC.

In respect of an alleged lack of novelty and inventive step the opposition was supported by:

- D1: US-A-2 421 463
- D2: US-Re- 21 316 (Reissue of US-A-2 031 888) and
- D3: Dubbel "Taschenbuch für den Maschinenbau",  
13th Issue, First Volume, Springer-Verlag, Berlin,  
Heidelberg, New York, 1970 pages 143 to 147.

III. By decision given at oral proceedings on 19 October 1990 with written reasons posted on 26 November 1990, the Opposition Division rejected the opposition.

The Opposition Division held the opinion that the skilled person would find adequate instructions in the patent, which, in combination with his general technical knowledge, would lead him directly towards successful selection of the appropriate combinations of values through the evaluation of initial failures and that therefore the patent did not contravene the requirements of Article 100(b) EPC.

Claim 1 of the patent was also considered to comprise novel and inventive subject-matter since none of the cited documents disclosed the whole combination of

features of Claim 1 and also no teachings could be derived from these prior art documents to the specific selection of parameters as claimed.

IV. An appeal was lodged against this decision on 2 February 1991, with payment of the appeal fee on the same day. The Statement of Grounds of Appeal was filed on 30 March 1991.

V. In a communication sent together with summons for oral proceedings, as had been auxiliary requested by both parties, the Board expressed the provisional opinion that the Appellant's arguments with respect to insufficiency of disclosure was not considered convincing. However, as regards inventive step, the Board expressed doubt whether an inventive activity was necessary to arrive at the relations claimed in Claim 1 when considering the skilled person's interpretations of the disclosures of D1 and D2.

VI. Oral proceedings were held on 11 November 1993.

At the oral proceedings the Board drew attention to the fixed interrelation of the claimed conditions A/B, C/B and e/B, which fact followed from the chosen type of pump, as well as from document D1.

VII. The Appellant requested that the decision under appeal be set aside and that the European patent No. 0 079 156 be revoked. In support of his requests he essentially relied upon the following submissions:

Article 100 (b) EPC objection:

In a computer simulation of the essential pump parameters, using values in the ranges for the three pump parameter combinations claimed in Claim 1, it was found that only some extreme values would be suitable to

construct a pump. However, large parts of the ranges claimed are not suitable to construct a pump and since it is essentially the subject-matter of the claim that, in accordance with Rule 29(1) EPC, defines the invention, the invention claimed cannot be considered as being disclosed in a manner sufficiently clear for it to be carried out by a person skilled in the art. The same result would be arrived at when applying the conclusions arrived at in the appeal Board's decisions T 292/85 (OJ EPO 1989, 275) and T 226/85 (OJ EPO 1988, 336).

Article 100(a) EPC objection:

The subject-matter of Claim 1 lacks novelty when compared with the disclosures of D1. Although this prior art document does not directly mention that its subject-matter relates to an oil pump, this can be derived from the text in column 3, lines 1 to 5, in which reference is made to proper lubrication of the teeth, which implies the use of oil.

From the mathematical relations disclosed in D1 can be derived that if  $R=E$ , thus the minimum value of  $R$  according to the text in column 5, line 9, the value  $e/B$  in accordance with the patent becomes 0.5 and  $C/B = 1$ . These values fall within the claimed ranges for  $e/B$  and  $C/B$  and if  $R>e$  than  $e/B<0.5$  and  $C/B>1$ .

The relations given for  $\Delta r$  and  $\Delta R$  obviously define nothing more than that a small clearance between the cooperating teeth must be present which, for proper functioning, has to be the case in the gear elements disclosed in D1 as well.

The single difference between the subject-matter of D1 and that claimed in Claim 1 of the patent in suit is thus that the relations disclosed in D1 apply to gear elements of any number of teeth in excess of two whereas

the patent restricts its selection to eight teeth and more.

However, in accordance with the appeal Board's jurisprudence, in particular in view of the decision T 17/85 (OJ EPO 1986, 406), novelty of a selection invention can be concluded only if the selected range is small and if it has sufficient distance to the known range, which conditions are not fulfilled in the present case. Therefore the subject-matter of Claim 1 must be considered to lack novelty.

Even if novelty is conceded, the subject-matter of Claim 1 cannot be considered to involve an inventive step. The single difference left when compared to the subject-matter disclosed in D1 is that D1 does not expressively mention cooperating gear elements with teeth values of 8 and 9.

However, if the skilled person seeks for a solution for the problem of high speed running pumps whereby cavitation and eccentric wear should be avoided, he is immediately confronted with the solution to this problem by D2.

D2 also relates to a gear pump constructed on the basis of the principles disclosed in D1. In column 3, lines 57 to 75, reference is made to abrasion and wear which is greater in pumps having lower numbers of teeth when speed is increased and, quite obviously, cavitation is more pronounced in pumps having a small number of pumping chambers because of the relatively high pressure differences between the pumping chambers.

This means that the skilled person is immediately led to increase the number of teeth, for example to a ten to eleven ratio mentioned on page 3, right-hand column.

line 67, when the pump disclosed in D1 would need improvement in this respect and would thus arrive in an obvious manner at the subject-matter of Claim 1.

VIII. The Respondent contested the Appellant's views and requested that the appeal be dismissed. His arguments can be summarised as follows:

Article 100(b) EPC objection:

The decision T 226/85 cannot be considered relevant in the present case because it deals with an extreme case not comparable with the present one. Moreover, Claim 1 satisfies the requirements set out in this decision in that the skilled person would not have great difficulties to find proper embodiments by following the instructions of the specification. Furthermore, the Appellant's contention that the subject-matter of Claim 1 cannot be reproduced for comparatively large ranges of parameters is unjustified; a proper and sensible approach would be for the skilled person to choose intermediate values well within the claimed limits rather than starting from the extremes as was done by the Appellant.

Article 100(a) EPC objection:

Novelty of the subject-matter of Claim 1 follows from the fact that neither D1 nor D2 discloses any of the values of the ranges claimed for gears with rotors having external teeth numbers higher than 8. In this respect the C/B value derived by the Appellant from D1 to be 1, does not relate to an embodiment of the gear element disclosed therein but rather is the result of a mathematically derived value for the minimum radius capable of being employed for the generating circle without undercutting of the teeth (see column 5, lines 9 and 10 of D1).



Neither D1 nor D2 relates to the underlying problem of the patent, e.g. the ability of the pump to be used at sustained high speeds up to 6000 rpm or even higher so that it can be mounted directly on the crankshaft of an automobile engine.

D1 does not even mention that the gear element disclosed therein can be used as an oil pump and also does not give any indication of the manner in which the clearance between the gear elements is achieved. In this respect D2 indeed refers to a provision of backlash (see page 4, right-hand column, line 69 to page 5, left-hand column, line 4) but this is achieved in a totally different manner when compared to the clearance relations defined in Claim 1 of the present patent.

There is thus nothing in D1 that would indicate the skilled person either particular values for the A/B, C/B and e/B ratios falling within the ranges claimed or the specific numerical ranges of these claimed ratios themselves. There is also no reason why the skilled person would manipulate the various general fundamental equations of D1, select, appreciate the significance of, and substitute an A/B ratio of 8 or more and then appreciate the significance of any C/B and e/B values falling within the claimed ranges or to extract a particular A/B ratio of D2 and apply it to D1 with the view to producing an improved oil pump directly driven from the crankshaft of an automobile engine. Considering the difficulties encountered with respect to sealing when more teeth are used for the rotors, in particular for high speed use, the skilled person would normally not increase the number of teeth.

## Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rules 1(1) and 64 EPC. It is admissible.
  
2. *Cited prior art*
  
- 2.1 The prior art disclosed in D1 relates to gear elements for fluid pumping purposes, with an inner gear element that has one tooth less than its cooperating outer gear element.

The outer gear element is mounted eccentrically with respect to the inner gear element such that the teeth of the inner gear element maintain contact with the cooperating teeth of the outer gear element over the entire rotational position thereof so as to provide a plurality of pumping chambers between the cooperating gear elements. During rotation of these elements the chambers subsequently increase and decrease in volume which results in a pumping action (see column 1, lines 1 to 20).

In D1 the general mathematical principles of such a gear type pump are disclosed as well as a specific example with an inner gear element having six teeth and an outer gear element having seven teeth.

The general mathematical principles are explained with reference to Figures 1 and 2, showing how the teeth form of the inner rotor is constructed, and the basic relations between the parameters involved for the pump to be realised. The major parameters are:

E = the eccentricity of the axes of the two gear elements  
N<sub>1</sub> = the number of teeth of the outer element  
N<sub>2</sub> = the number of teeth of the inner element  
D<sub>1</sub> = the outer diameter of the inner element at the teeth tops ( $D_1=2N_1E$ )  
B = radius of the base circle  
R = radius of the rolling circle  
G = generating radius.

For the type of pump disclosed in D1,  $N_2 + 1 = N_1$  (see column 1, line 31 to 41).

The relation between B and R is  $R = B/N_2$  (see column 4, line 32; and results from  $2\pi R.N_2 = 2\pi B$ : see column 4, lines 13 to 17) and the relation between the further parameters is  $B + R + E = D_1/2 + G$  (see relation (7) in column 4, line 73).

2.2 Document D2 discloses a tooth curve for gear elements, such as pumps and compressors, and although the exact generation of the tooth form is not described, it follows from the explanations of this patent specification that the tooth curve generation of the gear elements is similar to that of the gear elements disclosed in D1.

Examples of inner gear elements having 8 and 6 teeth are shown in the drawings and in the description reference is made to five to six, six to seven, seven to eight and ten to eleven ratios (see page 3, right-hand column, lines 57 to 75).

2.3 Document D3 gives the geometrical relations and definitions of the underlying principles of epitrochoids which are the basis for the construction of the inner

rotor of the type disclosed in the patent. However, these relations are already known from D1.

Furthermore, since the Appellant did not any longer rely in his submissions in the appeal proceedings on D3 it is not considered necessary to discuss this prior art in detail.

2.4 In the description of the patent in suit reference is made to a prior art internal gear oil pump having trochoid tooth profile (see also Figure 2). This pump (of 4-5 teeth configuration) is acknowledged in the precharacterising portion of Claim 1 of the patent in suit.

3. *Sufficiency of disclosure of the invention as required by Article 100(b) EPC*

3.1 As is clear from the description of the underlying principles of construction of the gear elements disclosed in the patent, these principles are essentially the same as set out in D1. This fact has neither been contested by the Appellant nor the Respondent. Indeed, it is common knowledge for a person skilled in the art, that the above (see section 2.1) basic relations between the different parameters needed to construct the inner gear element of this type of pump are **specific** for the chosen pump-type. Such basic relations furthermore cannot be chosen freely but are defined by the technical reality, i.e. the construction of that type of pump (see Figure 3 of the present European patent, as well as relation (7) in D1), so that due to the choice of that type of pump at least these commonly known basic relations have to be fulfilled. It is therefore obvious that the different constructional parameters themselves can only be chosen freely within

the already existing framework of those commonly known, constructionally defined relations.

When substituting the corresponding references used in the present patent ( $B=\frac{1}{2}A$ ,  $R=\frac{1}{2}B$ ,  $E=e$ ,  $G=\frac{1}{2}C$ ,  $N_1=n+1$ ,  $N_2=n$ ) in the above mentioned relation disclosed in D1:

$$B + R + E = D_1/2 + G \quad (D_1=2N_1E)$$

this relation will then read:

$$\frac{1}{2}A + \frac{1}{2}B + e = (n+1)e + \frac{1}{2}C \text{ and thus}$$

$$A + B = 2ne + C \quad (n=A/B).$$

Division by B results in  $n + 1 = 2ne/B + C/B$  (relation A).

3.2 As a consequence of the above function, the conditions  $A/B(n)$ ,  $C/B$  and  $e/B$ , specified in the Claim 1 of the patent in suit, have an already fixed constructionally defined relation with respect to each other. In the present case this also means for example that when two of these parameters are chosen freely the third is fixed by the selection of the two others.

3.2 Considering now the Appellant's objections with respect to insufficiency of disclosure of the invention, the Appellant essentially referred to computer simulations in an attempt to show that large areas of the claimed ranges did not allow a pump to be constructed.

However, as follows from the explanations concerning the set up of the simulation (see in this respect in particular page 3, penultimate paragraph of the Statement of Grounds of appeal) no account was taken of the above derived known, constructionally defined, basic interrelation of the parameters concerned and rather all three (interdependent) parameters were selected

individually to have a particular value taken from the claimed ranges. Therefore, as a result of the redundancy in the data entered, nothing else than an unsatisfactory simulation could be expected. Consequently the result of the simulation cannot be considered as convincing proof of the Appellant's contentions of insufficiency of disclosure.

- 3.3 Moreover, even if some combinations of values in the claimed ranges would not be suitable to construct a functionally satisfactory pump, this alone is not a sufficient reason for concluding insufficiency of disclosure if the skilled person in view of the known relation between the parameters concerned had no undue difficulties in arriving at a number of other combinations with which it is possible to construct a satisfactory pump.

In this respect, considering the selected conditions and their known relation in the form of the basic relation A referred to above, it would in the Board's opinion, be a matter of normal practise carried out by the skilled person to select a wanted number of teeth for the rotors and one of the other conditions first and to derive the value of the third condition from the relation A and to repeat this calculation as often as necessary with other values to come to combinations of values which fall both in the claimed ranges and meet the condition of the relation A. As will be immediately clear from the known relation A such simple calculations will result in many possible solutions with the conditions  $n$ ,  $e/B$  and  $C/B$  falling in the claimed ranges.

- 3.4 Summarising, considering that the mathematical interrelation of the conditions specified in Claim 1 is known and constructionally defined, the skilled person

would not encounter any difficulties finding values for these conditions falling in the specified ranges.

The decisions T 226/85 (OJ EPO 1988, 336) and T 292/85 (OJ EPO, 1989, 275) cited by the Appellant do not lead to a different conclusion because, as is shown above, the skilled person, who in view of the basic knowledge of the type of pump concerned should be attributed the knowledge of the mathematical principles of the gear elements concerned, did not have undue difficulties in finding parameter combinations which determine a pump in accordance with the subject-matter of Claim 1 of the patent in suit.

4. *Novelty*

4.1 From the above analysis of the cited prior art, including the prior art acknowledged in the description of the patent, it can be concluded that the subject-matter of Claim 1 of the patent in suit is novel because none of these documents discloses either the particular ranges for the values of the claimed conditions - including the specified relative R and r values - or combinations of specific values falling in the claimed ranges.

4.2 The Appellant submitted that the subject-matter of Claim 1 lacked novelty in view of the disclosure of D1, in particular when considering the conclusions of the decisions T 666/89 (OJ EPO 1993, 495) and T 17/85 (OJ EPO 1986, 406). However, his arguments are not considered convincing for the following reasons.

In D1 the mathematical principles of the cooperating gear elements used in the patent in suit are disclosed and one embodiment with a 6-7 teeth combination is explained in detail.

The 6-7 teeth example has a C/B ratio (=2.36) which falls in the claimed range but neither the values for A/B (=6) nor E/B (=0,387) fall within the claimed ranges and no information whatsoever is derivable from D1 as to the relative values of  $\Delta R$  and  $\Delta r$ .

In the discussion of the mathematical principles there is stated that in order to calculate the lower limit for an acceptable range of values for the generating radius (Gmin), it is assumed that the minimum value of  $R = E$ . However in the further text of D1 this value is clearly excluded for use (see column 4, lines 24 to 28 and column 7, lines 18 to 20) and cannot therefore be considered as a disclosure of a selected value for constructing a pump. Moreover, no indications are derivable from D1 as to what values should be selected for the conditions C/B and e/B, if gears with teeth numbers more than the 6-7 teeth example were selected.

Even if the Appellant were right in his contention that D1 discloses that when  $R=E$  than  $e/B=0.5$  and  $C/B=1$  and when  $R>E$  than  $e/B<0.5$  and  $C/B>1$ , D1 does not explicitly disclose a 8-9 teeth pump, nor pumps with higher teeth values, nor what conditions of e/B and C/B apply for these rotors, nor any conditions of the clearance between the rotors.

4.3 The subject-matter as set forth in Claim 1 therefore is to be considered novel within the meaning of Article 54 EPC.

5. *Inventive step*

5.1 Hitherto, it has been customary with oil pumps for internal combustion engines of the type having cooperating gear elements with trochoid tooth profile, such as shown in Figure 2 of the patent in suit, to



operate the pump with reduced speed through an idler gear or belt pulley arrangement which gives, however, rise to unwanted power losses.

When opting for direct drive from the crankshaft of the engine, the problem encountered with conventional internal gear pumps having a trochoid tooth profile is that if it is operated at high rotational speeds, cavitation or eccentric wear is likely to take place.

It is therefore the object of the present patent, to provide a relatively low cost oil pump for a fuel-cost saving internal combustion engine which does not give rise to the disadvantages referred to above (see page 1, lines 12 to 17 and 28 to 32 of the patent description).

5.2 When trying to find a solution to this problem the skilled person would, in the Board's opinion, not find sufficient information in the prior art to arrive at the claimed subject-matter without the exercise of an inventive activity.

Although D1 does not directly mention that the cooperating gear elements are used as an oil pump, their use as a fluid pumping mechanism is explicitly acknowledged (see column 1, lines 1 to 4) and, indeed, the mathematical principles on which the construction of the cooperating gear elements is based are identical with those of the oil pump in accordance with the patent in suit.

However, no indication whatsoever is derivable from D1 that rotors with teeth number pairs of 8-9 and more together with particular ranges for values of the constructional parameters  $e/B$  and  $C/B$  as well as clearances in accordance with the indications in Claim 1

of the patent in suit would provide a solution to the above-mentioned problem.

It is noted that D1 mentions advantages of the disclosed gear elements with respect to wear and noise (see column 1, line 27), but this effect is a direct consequence of the use of the trochoid tooth form which is however already included in the prior art oil pump acknowledged in the precharacterising part of Claim 1 of the patent in suit.

D2 refers to the use of the disclosed rotors as fuel oil pumps or air compressors and also indicates that the fewer the teeth the greater the abrasion or wearing effect is (see page 3, right-hand column, lines 57 to 75).

However, although the generating principles of the teeth of the rotors appear to be the same as in D1 and the present patent, no exact teachings are derivable from D2 in this respect. Moreover, although examples with 8-9 and 10-11 teeth ratios are mentioned, no disclosures or suggestions as to the further constructional parameters can be derived from this prior art and, as regards the clearances between the gear elements to be observed when they cooperate, particular machining steps are disclosed to provide "backlash" (see page 4, right-hand column, line 69 to page 5, left-hand column, line 4) or just a the provision of a "running in" step (see page 3, left-hand column, lines 33 to 37).

5.3 The Appellant argued that it would be obvious to the skilled person to consider the use of higher numbers of teeth in order to avoid cavitation for the reason that the pressure difference between the different pumping chambers, when their number increases, would be reduced.

However, considering that the inlet and outlet openings of the type of pump concerned are essentially configured as shown in Figure 2 of the patent, greater numbers of teeth for the rotors would not have the alleged effect since, determined by its construction, the pressure difference between the inlet and outlet openings is exerted in these kind of pumps over a single tooth only. The Appellant's argument in this respect is thus not convincing.

Also the reference in D2 to motor speeds of "1725 rpm or the like" (see page 3, right-hand column, lines 61 to 70) considered by the Appellant as a clear suggestion to use a higher number of teeth for the rotors when higher speeds are allowed, is not considered pertinent. In accordance with the same paragraph, this speed was also used for 5-6 and 6-7 ratios and thus no preference for teeth ratios of 8-9 and higher for speeds in the order of crankshaft speeds of modern motor vehicles can objectively be derived from this statement in D2.

- 5.4 Summarising, in the Board's judgment, the proposed solution to the technical problem underlying the patent in suit defined in the independent Claim is inventive.
  
6. Claim 1, as well as its dependent Claims 2 and 3, relating to particular embodiments of the invention in accordance with Rule 29(3) EPC, define patentable subject-matter so that the patent can be maintained unamended.

Order

For these reasons, it is decided that:

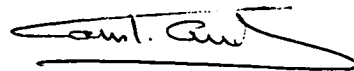
The appeal is dismissed.

The Registrar:



N. Maslin

The Chairman:



C. Andries

