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**Datasheet for the decision  
of 20 February 2013**

**Case Number:** T 0555/09 - 3.2.05

**Application Number:** 01310288.4

**Publication Number:** 1215422

**IPC:** F16J 15/32

**Language of the proceedings:** EN

**Title of invention:**

Rotary machine with a brush seal for a bearing cavity

**Patent proprietor:**

General Electric Company

**Opponent:**

MTU Aero Engines GmbH

**Headword:**

-

**Relevant legal provisions (EPC 1973):**

EPC Art. 56

**Keyword:**

"Inventive step - no"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 0555/09 - 3.3.05

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.05  
of 20 February 2013

**Appellant:**  
(Opponent)

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**Representative:**

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**Respondent:**  
(Patent Proprietor)

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**Representative:**

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**Decision under appeal:**

**Decision of the Opposition Division of the  
European Patent Office posted 12 January 2009  
rejecting the opposition filed against European  
patent No. 1215422 pursuant to Article 101(2)  
EPC.**

**Composition of the Board:**

**Chairman:** M. Poock  
**Members:** H. Schram  
W. Ungler

## Summary of Facts and Submissions

I. On 2 March 2009 the appellant (opponent) lodged an appeal against the decision of the opposition division, posted on 12 January 2009, by which its opposition against European patent No. 1 215 422 was rejected. The statement of grounds was filed on 13 May 2009.

II. Oral proceedings were held before the board of appeal on 20 February 2013.

The respondent (patent proprietor) informed the board on 10 January 2013 that it would not be represented at the oral proceedings.

III. The appellant requested that the decision under appeal be set aside and that the patent in suit be revoked.

The respondent requested that the appeal be dismissed.

IV. The documents referred to in the appeal proceedings included the following:

D1 GB-B 839,731;

D5 EP-A 1 070 887;

D6 *Development of a low hysteresis brush seal for modern engine applications*, Tseng, TW, Short, JF and Steinetz, BM, AIAA 99-2683;

D7 EP-A 1 070 888.

V. Claim 1 of patent as granted reads as follows:

"1. A rotary machine comprising:

a rotatable component (14);

a component fixed against rotation including a housing having a wall and a bearing in a bearing cavity (16) on one side of the wall, the bearing cavity containing an oil mist generated by the rotation of the rotatable component in the bearing cavity;

a seal (24, 36, 38) between the rotatable component and housing wall for substantially sealing the oil mist in the bearing cavity (16) from migration outwardly of the bearing cavity past the wall, said seal including a brush seal carried by said housing wall and having flexible bristles (30, 48) engaging said rotatable component and a backing plate (26, 44, 46) for supporting said bristles:

characterised by said bristles being formed of a polymer material and having a stiffness less than  $271456692 \text{ Pa}\cdot\text{m}^{-1}$  (1 psi/mil)."

VI. The arguments of the appellant, in writing and during the oral proceedings, can be summarized as follows:

The characterising portion of claim 1 as granted required that the bristles were formed of a polymer material and had a stiffness less than 1 psi/mil. In other words, in order to distinguish the invention from the prior art, a stiffness range was chosen that was immediately below the range known from that art.

In the patent itself it was stated that conventional brush seals employed Kevlar<sup>®</sup> bristles having a stiffness on the order of 1 to 2 psi/mil, cf column 4, lines 30

to 33. This left the person skilled in the art with only two possibilities, or rather two directions, for designing a brush seal outside that known range: either choosing a stiffness above the known range, ie more than 2 psi/mil, or below the known range, ie less than 1 psi/mil. The former possibility corresponded to bristles having a higher stiffness (lower softness), the latter to bristles having a lower stiffness (higher softness) with respect to the known range. The person skilled in the art would choose the second possibility, since softer bristles reduced the friction between the bristle tips and the shaft of the rotary machine and therefore the risk of coking was avoided and wear of the bristles and of the shaft due to said friction was reduced.

Document D1 could also be considered as the closest prior art for assessing inventive step. Grease was only mentioned as a possible lubricant for the bearing (page 1, lines 75 to 77, and page 2, line 129 to page 3, line 1). It was obvious to the person skilled in the art to use another lubricant such as oil. An embodiment of document D1 using oil as a lubricant had all the features of the preamble of claim 1 as granted, since the rotary movement of the shaft within the bearing cavity inevitably generated an oil mist. The bristles could be formed of nylon or teflon, see column 3, line 110. The sole feature that was not known from document D1 was the stiffness of the bristles. The person skilled in the art would choose bristles having a low stiffness in order to reduce the friction between the bristle tips and the shaft for the reasons mentioned above. Bristles having a low stiffness were

known from document D6, see seal designs 1, 2, 4 and 5 shown in Table 1.

The subject-matter of claim 1 as granted lacked therefore an inventive step.

VII. The arguments of the respondent, in writing, can be summarized as follows:

One objective technical problem that might be envisaged by the skilled person to exist with respect to the cited prior art documents could be, for example, how to improve the operational reliability of a rotary machine. Neither document D5 nor D7 recognised that said problem existed or suggested a bristle pack as claimed with a view to addressing said problem.

Document D6 taught away from the invention since it required use of a Haynes alloy material for the bristles rather than a polymer material as in the invention. Haynes materials have caused rotor bowing issues in the past and have gives rise to serious vibrational problems. The skilled person would therefore not combine the teachings of document D6 with the teachings of documents D5 or D7.

None of the cited prior art documents either alone or in combination disclosed or suggested a rotary machine as defined in claim 1 of the patent in suit. Said claim thus possessed an inventive step.

## Reasons for the Decision

1. The appeal is admissible.
  
2. Ground for opposition "lack of inventive step",  
Article 100(a) EPC 1973 in combination with  
Article 56 EPC 1973
  
- 2.1 A suitable starting point for assessing inventive step  
is a rotary machine comprising a labyrinth seal for  
sealing the oil mist in the bearing cavity as described  
and shown in the patent in suit, see paragraphs [0003]  
and [0009] and Figure 1.

Claim 1 differs from the rotary machine known from said  
prior art in that

- (i) said seal including a brush seal carried by said  
housing wall and having flexible bristles (30,  
48) engaging said rotatable component and a  
backing plate (26, 44, 46) for supporting said  
bristles,
  
- (ii) said bristles being formed of a polymer material  
and
  
- (iii) having a stiffness less than  $271456692 \text{ Pa}\cdot\text{m}^{-1}$   
(1 psi/mil).

In plain words, the invention proposes to replace the  
labyrinth seal known from the prior art machine by a  
brush seal with bristles formed of a polymer material  
and having a low stiffness.

2.2 That labyrinth seals have serious shortcomings in adequately sealing off large diameter bearing assemblies (cf column 1, lines 45 to 58, of the patent in suit) has already been pointed out in document D1 published in 1960 (see page 1, lines 22 to 35). In this document, which is cited in paragraph [0004] of the patent in suit, it was proposed to use instead a sealing device in the form of an annular brush comprising bristles of horsehair, or of a material in fibre form such as nylon or teflon (claim 1 and page 3, lines 109 to 111).

Brush seals having bristles engaging the rotatable component and comprising front and back plates for supporting said bristles have been proposed for use between a rotor and a surrounding casing in gas and steam turbines, see document D5, paragraph [0008], and document D7, paragraph [0011]. Both documents propose to use bristles formed of a polymer material, namely bristles made of filaments of a filament yarn made of nylon, polyester, fluorocarbon or an aramid such as Kevlar<sup>®</sup>, see document D5, paragraph [0016], and document D7, paragraph [0011].

In the judgment of the board, it was thus obvious to the person skilled in the art, starting from a rotary machine comprising a labyrinth seal as described in point 2.1 above, and seeking to provide a rotary machine having an effective, low-cost seal (cf column 1, lines 54 to 58, of the patent in suit) to replace the labyrinth seal by the brush seal known from document D5 or D7.



2.3 The person skilled in the art knows that a brush seal is a contact type of seal, whereby frictional heat develops due to the fact that the tips of the bristles engage a rotatable surface, cf for example document D1, page 1, lines 35 to 43. It is further known from this document that the frictional drag may be diminished by reducing the force of engagement, ie by making the fibres more flexible, cf page 3, lines 103 to 107.

Whilst the patent in suit does not provide a definition of the term "stiffness", and does not explain the unit [Pa/m], this term and its unit are known in the art, see document D6, page 4, Table 1. The stiffness is defined in this document (see page 3, right column, last paragraph) as the force component normal to the rotor surface required to displace 1 in<sup>2</sup> of bristles 1 mil in radial direction. It can be viewed as the pressure required at the bristle tips to displace them radially by a unit magnitude. The "force of engagement" mentioned in document D1 corresponds to the notion of "stiffness" in the patent in suit.

Document D6 discloses brush seals comprising bristles made of Haynes 25 (a cobalt alloy) having a diameter of 6 mil (152,4 µm) and having a stiffness of 0.72, 0.67, 1.08, 0.8 (0.08 is probably a typographical error) and 0.99 psi/mil, respectively, see page 3, right column, section "Seal Configuration", and page 4, Table 1 and Figure 4.

In the judgment of the board, it was therefore obvious to the person skilled in the art, trying to reduce the frictional heat released in operation of the brush seals known from document D5 or D7 to make their

stiffness as low as possible, for example in the range of 0,67 to 1,08 psi/mil as suggested by document D6, and thus to arrive at the claimed invention.

- 2.4 It follows that the subject-matter of claim 1 of the patent in suit was obvious to the person skilled in the art and thus does not involve an inventive step in the meaning of Article 56 EPC 1973.

### **Order**

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

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:

The Chairman:

D. Meyfarth

M. Poock