

**Internal distribution code:**

- (A)  Publication in OJ  
(B)  To Chairmen and Members  
(C)  To Chairmen  
(D)  No distribution

**Datasheet for the decision  
of 5 April 2011**

**Case Number:** T 0758/09 - 3.2.08

**Application Number:** 05254712.2

**Publication Number:** 1634971

**IPC:** C22C 14/00

**Language of the proceedings:** EN

**Title of invention:**

Application of high strength titanium alloys in last stage turbine buckets having longer vane lengths

**Applicant:**

GENERAL ELECTRIC COMPANY

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56

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

-

**Keyword:**

"Inventive step - (no)"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 0758/09 - 3.2.08

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.08  
of 5 April 2011

**Appellant:** GENERAL ELECTRIC COMPANY  
**Applicant:** 1 River Road  
Schenectady, NY 12345 (US)

**Representative:** Goode, Ian Roy  
London Patent Operation  
General Electric International, Inc  
15 John Adam Street  
London WC2N 6LU (GB)

**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 24 October 2008  
refusing European patent application  
No. 05254712.2 pursuant to Article 97(2) EPC.

**Composition of the Board:**

**Chairman:** T. Kriner  
**Members:** R. Ries  
E. Dufrasne

## **Summary of Facts and Submissions**

I. By its decision dated 24 October 2008, the examining division refused European patent application 05254712.2 on the ground of lack of inventive step of the subject matter of claim 1 then on file.

II. On 5 January 2009, the applicant lodged an appeal against the decision of the examining division and paid the appeal fee on the same date. The statement setting out the grounds of appeal was received on 3 March 2009. Enclosed therewith, the appellant submitted a revised set of claims 1 to 5 replacing the former request underlying the impugned decision.

III. In a communication annexed to the summons to oral proceedings, the Board gave its provisional assessment of the case. In particular, it was indicated that the subject matter of claim 1 did not involve an inventive step over the technical disclosure of document

D7: US-A-4 167 427.

IV. Oral proceedings took place before the Board on 5 April 2011.

The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of claims 1 to 5 submitted on 3 March 2009.

Independent claims 1 and 5 read as follows:

"1. A bucket for use in the last stage of a steam turbine engine, said bucket being formed with a vane length of at least 40 inches (1m) and comprising a titanium-based alloy having 3% up to 6.25% by weight aluminum, up to 3.5% vanadium, up to 2.25% tin, up to 2.25% zirconium, 1.75% to 5.0% molybdenum, up to 2.25% chromium, up to 0.7% silicon and up to 2.3% iron, with the balance being titanium."

Independent claim 5 is concerned with a method for manufacturing a last stage turbine bucket in accordance with claim 1.

V. The appellant's arguments can be summarized as follows:

Last stage steam turbine buckets having vane lengths of 40 inches or greater posed particular design problems in that they experienced higher tensile loadings and were subject to cyclic stresses and water droplet impact erosion since the steam in the last stage was "wet" (A2-publication of the application, paragraph [0005]).

These problems were solved through the claimed bucket consisting of the Ti-based alloy set out in claim 1. The titanium based alloy exhibited, inter alia, a minimum ultimate tensile strength (UTS) of 145 ksi at room temperature and UTS of 125 ksi at 400°F so that the bucket could be operated near 400°F.

Document D7 disclosed neither a last stage steam turbine bucket nor the vane length set out in the application. Moreover, the Ti-based alloy referred to in document D7 had a vanadium content of 4%, which fell

outside the claimed range for vanadium. Starting from the disclosure of D7, the skilled person was not prompted to select the Ti-based alloy set out in claim 1 for designing a last stage steam turbine bucket having vane lengths of 40 inches or greater.

The subject matter of claim 1 was, therefore, novel and involved an inventive step.

### **Reasons for the Decision**

1. The appeal is admissible.

2. Interpretation of claim 1:

The application relates to a bucket for use in the last stage of a steam turbine, said bucket being formed with a vane length of at least 40 inches and comprising a specific Ti-based alloy. The term "a bucket *for use in...*" is not construed as limiting the use of the bucket exclusively to the claimed purpose. Rather it is understood as meaning that the bucket is suitable for the stated use.

Contrary to the appellant's position, definitions of elemental range such as "*up to...%*" or "*less than ....%*" include the range of contents down to 0%. Hence, the elements vanadium, tin, zirconium, chromium, silicon and iron featuring in the composition of the claimed Ti-alloy are merely optional components which can be totally absent.

3. Novelty and inventive step

3.1 Like the present application, document D7 is concerned with improvements in heat-treating titanium alloys which are used in manufacturing rotating blades of steam turbines and the like, particularly of large sizes or for high speed operations. The  $\alpha+\beta$  titanium-based alloys used in document D7 provide better mechanical properties and material damping characteristics especially for low-pressure stage applications in steam turbines. Particular reference is made to material B given in D7, Tables 1 and 2 and comprising (by weight) 6% aluminium, 4% vanadium, 3% molybdenum, residual amounts of Fe, C, O, N, and H, the balance being Ti (D7, column 1, lines 1 to 17; line 66 to column 2, line 3; column 8, lines 33 to 41). Thus, it can be inferred from the disclosure of document D7 that the known Ti-based alloy is suitable for producing buckets having blades or vanes of large sizes and which can be used in particular in the last stage of a steam turbine engine, i.e. at a high radial speed.

The composition of alloy B: Ti-6Al-4V-3Mo falls within the elemental ranges of the Ti alloy used in the present application, except for the vanadium content of 4%, which is slightly outside the range of up to 3.5% V for the alloy set out in claim 1. Moreover, document D7 does not disclose a specific vane length.

The subject matter of claim 1 is, therefore, novel over the disclosure of document D7.

3.2 The vanadium content in material B is, however, rated as coming close to the upper limit of 3.5% of the range

defined for vanadium in claim 1. As to the effect associated with the addition of vanadium on the physical and mechanical properties of the claimed bucket, it is noted that the application fails to disclose any technical reason as to why the upper limit of 3.5% is critical and, therefore, should be adhered to. To the contrary, the Ti-based alloy composition used according to the application categorizes vanadium merely as an optional element, which can be totally absent, rather than as an indispensable and compulsory constituent. In the absence of any technical information to the contrary, it is therefore concluded that the upper limit for vanadium has been selected arbitrarily rather than intentionally for the Ti-based alloy featuring in claim 1.

The same argument is true for the vane length of more than 40 inches. It is well known in the art that final-stage moving blades in steam turbine engines should be as long as possible. The technical feature "a bucket being formed with a vane length of at least 40 inches" is therefore considered to represent merely one of several straightforward possibilities from among which the skilled person would choose without inventive merit when putting into practice the technical teaching of D7.

Given this situation, claim 1 does not comprise technical features amounting to an inventive step vis-à-vis the technical disclosure of document D7.

3.3 With respect to this finding, there is no reason to assess inventive step of the subject matter of independent claim 5.

**Order**

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

The appeal is dismissed.

The Registrar:

The Chairman:

V. Commare

T. Kriner