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Datasheet for the decision of 5 March 2019

Case Number: T 0124/15 - 3.2.06

Application Number: 04254496.5

Publication Number: 1503036

IPC: F01D5/02, F01D5/06

Language of the proceedings: EN

Title of invention:
Contoured turbine disk bore

Patent Proprietor:
United Technologies Corporation

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC Art. 54(2), 56

Keyword:
Novelty - main request (yes)
Inventive step - main request (no) - auxiliary request (no)

Decisions cited:

Catchword:

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Case Number: T 0124/15 - 3.2.06

D E C I S I O N
of Technical Board of Appeal 3.2.06
of 5 March 2019

Appellant: (Opponent)	Siemens Aktiengesellschaft Werner-von-Siemens-Straße 1 80333 München (DE)
Representative:	Siemens AG Postfach 22 16 34 80506 München (DE)
Respondent: (Patent Proprietor)	United Technologies Corporation 10 Farm Springs Road Farmington, CT 06032 (US)
Representative:	Dehns St. Brides House 10 Salisbury Square London EC4Y 8JD (GB)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 19 November 2014 concerning maintenance of the European Patent No. 1503036 in amended form.**

Composition of the Board:

Chairman	M. Harrison
Members:	P. Cipriano
	W. Ungler

Summary of Facts and Submissions

I. An appeal was filed by the appellant (opponent) against the interlocutory decision of the opposition division in which it found that European patent No. 1 503 036 in an amended form met the requirements of the EPC.

II. The appellant requested with its grounds of appeal that the interlocutory decision be set aside and the European patent be revoked.

III. The respondent (proprietor) requested in its reply that the appeal be dismissed, auxiliarily that the patent be maintained in an amended form according to the auxiliary request filed with letter dated 30 July 2015.

IV. The following document, referred to by the appellant in its grounds of appeal, is relevant to the present decision:

D1 DE 3400835 A1

V. The Board issued a summons to oral proceedings including a communication containing its provisional opinion, in which it indicated *inter alia* that the subject-matter of claim 1 of the main request (i.e. the amended form found allowable by the opposition division) did not seem to involve an inventive step.

VI. Oral proceedings were held before the Board on 5 March 2019, during which the parties confirmed the foregoing requests.

VII. Claim 1 of the main request reads as follows:
"1. A turbine disk (11), comprising:

a disk bore (13) disposed about a centerline (12), said disk bore having a bore width; and

said disk bore (13) comprising in the width direction a contoured shape having a contour depth (33); characterised in that:

a ratio of said contour depth (33) divided by said bore width is between .04 and .12, so as to minimise the maximum hoop stress realised across the disk bore (13) and to minimise the maximum hoop stress differential across said disk bore, wherein said contoured shape is a smooth curve, and is a conic section."

Compared to claim 1 of the main request, claim 1 of auxiliary request 1 further includes the feature that the conic section "is semi-circular".

VIII. The arguments of the appellant may be summarised as follows:

Main request - novelty

The feature

"a ratio of said contour depth (33) divided by said bore width is between .04 and .12, so as to minimise the maximum hoop stress realised across the disk bore (13) and to minimise the maximum hoop stress differential across said disk bore" (hereinafter referred to as "feature 4")

was not disclosed explicitly in D1 but was clearly recognizable from the Figures 3A and 3B by the skilled person.

As stated in the Guidelines (G-VI.6), since the turbine disk in D1 was identical to the one of claim 1, the burden of proof lay on the respondent to prove that the unknown parameter (the ratio defined in feature 4) was not derivable from D1.

The feature "said contoured shape is a conic section" (hereinafter referred to as "feature 6") was disclosed in Figure 1 of D1, which disclosed a symmetrical contoured shaped that was thus necessarily a conic section, such as a circle, an ellipse or a parabola.

Main request - inventive step

Assuming that D1 did not disclose features 4 and 6, the differing features did not provide any effect over the prior art. Thus the objective problem was to provide an alternative contoured shape for the disk bore.

The ratio was arbitrary and did not provide an effect over the whole range of the claim, i.e. for every claimed disk geometry.

A conic section was just an obvious possibility that did not provide any advantage.

The skilled person would, without the exercise of inventive step, choose a conic section, such as an arc of a circle, an ellipse or a hyperbola, which are among the simplest shapes from which the skilled person would start when trying to give a concrete shape to the contoured shape of D1.

Auxiliary request - inventive step

A semi-circular shape did not provide any additional effect over any other conic section.

The patent did not claim or otherwise disclose inspecting a disk bore, so the objective problem could not be related to the inspection of the disk. Even if this were the case, there was no reduction of the inspection time as the number of points to be inspected depended much more on the size and the manufacturing tolerances required than on the specific shape of the bore. Further, the actual bore in the disk had a three-dimensional barrel shape and was not a simple semi-circle that could be defined by three points.

As for the main request, a semi-circular shape was just an obvious possibility that did not provide any advantage. The skilled person would select such a shape without exercising an inventive step.

IX. The arguments of the respondent may be summarised as follows:

Main request - novelty

The subject-matter of claim 1 did not disclose features 4 and 6.

It was not permissible to take measurements from Figures in a patent document, such that a ratio of two values (feature 4) could not be derived unambiguously from Figure 1 of D1.

In addition, the drawings of D1 were purely schematic and as such could not be used to derive if the bore hole of D1 was in the shape of a conic section (feature 6).

Main request - inventive step

Starting from D1 as the closest prior art, the objective problem to be solved was to provide a turbine disk with reduced hoop stress and weight, which was both simple and economical to design.

D1 did not disclose or teach any suitable shape for simplifying the fabrication thereof, while still providing a suitable reduction in hoop stress. In contrast to D1, the disk bore of the invention did not need to be designed with the help of a Finite Element method (FEM).

The ratio of said contour depth divided by said bore width was chosen to provide an appropriate hoop stress and weight reduction through the removal of excess material.

There was no hint in D1 for the skilled person to use a curved shape such as a conic section - a rectangular cut-out with rounded edges would be enough.

Auxiliary request - inventive step

The objective technical problem was to simplify the manufacture and inspection of the bore shape.

D1 did not disclose or teach the skilled person any need for simplifying the fabrication or the inspection of the bore shape, nor any shape which would meet this need. Thus, the skilled person had no motivation to use common general knowledge to arrive at the semi-circular shape.

Machining more complicated shapes than a semi-circular shape took longer. Further, in the case of a semi-circular shape, inspection of the bore measurements was particularly simple, since only three points were required in order to calculate a radius and a centre for comparison with the target values and to check if the bore shape had been produced correctly.

Turbine disks were subject to heavy loads and tight safety requirements that necessarily required an inspection. The turbine disk of claim 1 thus implicitly contemplated an inspection since this was always in the mind of the designer.

Reasons for the Decision

1. Main request - novelty

1.1 There was no dispute between the parties that the features of claim 1 other than features 4 and 6 were disclosed in D1.

1.2 In regards to feature 4, the Board finds that D1 does not disclose this. Contrary to the argument of the appellant, and without a specific teaching, concrete values derived only by performing measurements from the drawings in D1 (which notably do not specify either the countour depth or the bore width) are not part of the unambiguous disclosure of D1. This is also in accordance with the established Case Law of the Boards of Appeal (see e.g. Case Law of the Boards of Appeal, 8th ed. 2016, I.C.4.6.) and nothing in the present case

can be seen to give a reason to diverge from this established practice.

1.3 The Board is also not persuaded by the argument of the appellant that the turbine disk in D1 was identical to the one claimed apart from feature 4 such that the burden of proof to show that the ratio was not disclosed in Figure 1 of D1 lay with the respondent. Even though the Board is not bound by the Guidelines for Examination, the appellant's reference to the Guidelines G-VI.6 would anyway not alter the Board's finding since here it is stated that the known and the claimed products should be identical in all other aspects apart from the parameter. In the absence of the concrete dimensions of either the claimed or the known turbine disk in D1, it is impossible to establish the extent to which the turbine disks are identical. Thus the skilled person would neither inevitably arrive at a result falling within the terms of the claim merely by considering the remaining disclosure of D1 nor is it implicit that the ratio derivable from Figure 1 of D1 must have the claimed ratio. Feature 4 is thus not disclosed in D1.

1.4 The Board also finds that D1 does not disclose feature 6. Although it has not been disputed that Figure 1 of D1 discloses a contoured shape, it is not clearly and unambiguously derivable for the skilled person that such a contoured shape is a conic section, (i.e. a section which only comprises semi-circles, parabolas, hyperbolas and ellipses). Contrary to the argument of the appellant, even regarding the fact that Figure 1 of D1 discloses a symmetrical turbine disk (see e.g. D1, page 5, lines 3 to 8), the depicted bore shape would not necessarily be a conic section and could be any contoured shape comprising two inflection points, such

as a sinusoidal curve or even a cubic curve. Feature 6 is thus not disclosed in D1.

1.5 Since features 4 and 6 are not disclosed in D1, the subject-matter of claim 1 is novel over D1.

2. Main request - inventive step

2.1 The appellant argued that the subject-matter of claim 1 did not involve an inventive step when starting from D1 as the closest prior art and considering the knowledge of the skilled person.

2.2 As discussed above, when starting from D1, Figure 1, as the closest prior art, the subject-matter of claim 1 differs from D1 by features 4 and 6.

2.3 The objective technical problem which can be derived from the differing features is to provide an appropriate alternative contoured shape. Neither feature 4 nor feature 6 provide an additional technical effect over the turbine disk disclosed in D1, Figure 1.

The argument of the respondent that the objective problem was to provide a turbine disk with reduced hoop stress and weight, but that was both simple and economical to design or manufacture, is not accepted by the Board.

Feature 4 does not provide any additional effect over the disk bore disclosed in D1, since any effect on hoop stress provided by the ratio countour depth/bore width is highly dependent on the cross-sectional shape of the turbine disk, the latter notably not being defined in claim 1, such that it cannot be concluded that any advantage with regard to stress reduction occurs. It is

noted that the patent in suit (see e.g. paragraph [0014]) also does not disclose any technical effect achieved by this ratio and no other data attesting to any other effect was made available by the respondent. Thus, the claimed ratio in feature 4 must be regarded merely as an arbitrary selection not providing any recognisable technical effect over the prior art, apart from being an alternative contoured shape.

Feature 6 also does not provide a reduced hoop stress with regard to the contoured shape disclosed in D1. D1, Figure 1 and page 3, lines 23 to page 4, line 4, as well as the sentence bridging pages 4 and 5, discloses a bore formed as a smooth curve iteratively using a finite element method (FEM method) in order to minimise stress distribution. The Board finds that defining the contoured shape specifically as a conic section does not reduce the hoop stress and weight further than forming it generally as a smooth curve using a FEM method and is thus simply an alternative contoured shape.

Contrary to the argument of the respondent, it is not excluded by the subject-matter of claim 1 (or any other disclosure in the patent) that the turbine disk with a disk bore comprising a contoured shape of conic section is also designed by FEM. FEM requires the user to set the cross-sectional shape and the operating parameters of the turbine disk in order for (in this particular case) the hoop stress distribution to be calculated. In addition, the manufacturing speed and simplicity depend almost exclusively on the quantity of material to be removed and on the dimensional tolerances required rather than on the basic shape to be obtained. The skilled person may therefore use a FEM iteratively in order to find the suitable type and dimensions for the

claimed conic section, which is thus neither simpler nor more economical to design or manufacture.

2.4 Faced with the technical problem of providing an appropriate alternative contoured shape, the skilled person would arrive at the subject-matter of claim 1 in an obvious manner.

The provision of a disk bore with the claimed ratio of feature 4 is, as shown above, an arbitrary selection, because it does not provide any recognisable technical advantage in design or in hoop stress reduction.

In addition, the use of a conic section as defined in feature 6 is one of the many obvious possibilities without any supplemental technical advantage or effect - paragraph [0014] of the patent discloses that the contoured disk bore may be of any shape sufficient to requisitely lessen the maximum hoop stress across the disk bore. The skilled person would thus use a contour shaped being a conic section when specifying a shape to the contoured shape of the disk bore in Figure 1 of D1 in an obvious manner, since this is merely one of many suitable possibilities from which they can choose.

2.5 The argument of the respondent that there was no hint in D1 for the skilled person to use a curved shape being a conic section is also not convincing. D1, Figure 1 and page 3, lines 23 to 32, as well as on the sentence bridging pages 4 and 5, already disclose the use of a generally smooth curved contoured shape, such that a skilled person starting from D1 would not consider, for example, a rectangular cut-out as starting point(as argued by the respondent). The skilled person is already instructed by D1 to start from a smooth curve and knows from well known

mechanical principles that same-stress lines do not have sharp edges, such that there is a clear hint for them to search from a simple curved shape such as a conic section.

2.6 For the above reasons, the subject-matter of claim 1 of the main request is obvious to a skilled person when starting from D1 and given the technical problem to be solved when considering common general knowledge. The subject-matter of claim 1 therefore does not involve an inventive step (Article 56 EPC). The main request is thus not allowable.

3. Auxiliary request - inventive step

3.1 Claim 1 of the auxiliary request has been amended to define that the conic section is semi-circular.

3.2 The objective problem is the same as discussed under point 2.3, 1st paragraph, i.e. to provide an appropriate alternative contoured shape. The Board finds that the specific semi-circular shape does not provide any recognisable technical effect over the shape in D1.

3.3 The argument of the respondent that the semi-circular shape allowed a simpler fabrication and inspection by requiring only three inspection points, does not convince the Board.

First, the Board does not recognize (contrary to the argument of the respondent) why it would be simpler to produce a semi-circular shape than any other contoured shape. As stated already above, the manufacturing speed and simplicity depend essentially on the quantity of material to be removed and on the dimensional

tolerances required than on the basic shape to be obtained.

Second, even assuming that an inspection is implicitly part of the disclosure of the patent, the number of points required to inspect a manufactured piece is defined not only by the shape of the piece but by the size and the dimensional tolerances as well. In addition, although three points are enough to define a circle (as the respondent argued) or a semi-circle as seen in the cross-section figure of the patent, the surface of the manufactured piece is a three-dimensional shape (a barrel-shaped cylinder) obtained by the revolution of said semi-circle around the turbine disk axis. To assess or inspect the actual shape of a barrel-shaped bore of a turbine disk, the skilled person would certainly require more than three points in accordance with the required dimensional tolerances.

3.4 For the reasons discussed above and under point 2.4, the Board finds that a semi-circular shape is a simple possibility that the skilled person would recognize among the various types of conic sections not providing any advantage or effect. The skilled person would thus chose a semi-circular shape when choosing a suitable alternative shape for the contoured shape of the disk bore of Figure 1 of D1 in an obvious manner.

3.5 For the above reasons, the subject-matter of claim 1 of the auxiliary request is obvious to a skilled person when starting from D1 and given the technical problem to be solved when considering common general knowledge. The subject-matter of claim 1 therefore does not involve an inventive step (Article 56 EPC). The auxiliary request is therefore not allowable.

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:

A. Pinna M. Harrison

Decision electronically authenticated