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(74) Agent: **FRÖHLING, Werner**; Volvo Technological
Development Corporation, Corporate Patents, CTP 06820,
Sven Hultins Gata 9c, S-412 88 Göteborg (SE).

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(71) Applicant (for all designated States except US): **VOLVO
AERO CORPORATION** [SE/SE]; S-461 81 Trollhättan
(SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **LUNDGREN, Jan**
[SE/SE]; Dammenvägen 17, S-450 33 Grundsund (SE).
CARLSSON, Joakim [SE/SE]; Snärsbo Siviken 290,
S-462 91 Vänersborg (SE). **JONSSON, Peter** [SE/SE];
Solhemsvägen 13, S-463 75 Hjärtum (SE). **NORDIN,
Börje** [SE/SE]; Lilla Värviksvägen 61, S-461 59 Trollhät-
tan (SE).

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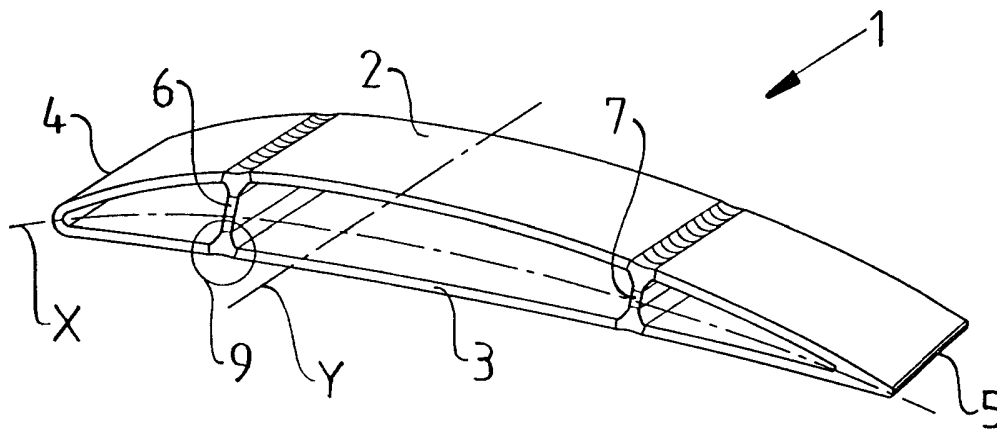
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ning of each regular issue of the PCT Gazette.

(54) Title: A METHOD FOR MANUFACTURING A HOLLOW BLADE FOR A STATOR OR ROTOR COMPONENT



(57) Abstract: The invention relates to a method for manufacturing a hollow blade (1) intended for a stator component or rotor component, at least one support element (6, 7) being positioned between two opposite blade walls (2, 3) and joined together with these by welding. The support element (6, 7) is joined together with at least one of the blade walls (2, 3) by means of laser-welding from the outside of the blade in such a way that the joined-together portions of the support element and the blade wall form a T-shaped joint (9).



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A method for manufacturing a hollow blade for a stator or rotor component

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FIELD OF THE INVENTION

The present invention relates to a method for manufacturing a hollow blade intended for a stator component or rotor component, at least one support
10 element being positioned between two opposite blade walls and joined together with these. The stator component or rotor component can be used in, for example, a gas turbine and in particular in a jet engine.

15

The term jet engine includes various types of engine which take in air at relatively low speed, heat it by combustion, and discharge it at much higher speed. The term jet engine includes, for example, turbo-jet engine
20 and turbo-fan engine.

The blades can therefore be used for both static and rotary parts. In the former case, the blade can be used as what is known as a strut. Such struts are arranged
25 between an outer ring and an inner ring in the stator. In stators, the struts are chiefly intended to be force-transmitting and usually have such a shape that they offer as little air resistance as possible. The struts can, for example, be arranged in a rear or front
30 support in a jet engine. In rotors, the blades can be used as fan blades for the purpose of deflecting a flow, for example in a jet engine.

The blades are of hollow design for the purpose of
35 optimizing their weight. The support elements are arranged between the blade walls in order to reinforce the blades and are therefore often referred to as reinforcing ribs.

PRIOR ART

According to prior known art, the joining together of the support element and the blade walls has been carried out by means of resistance welding. In this case, the support element is elongate with a U-shaped cross section, the support element being positioned so that each of the two legs of the U extends parallel to and in contact with a blade wall. The intermediate part of the U then forms a spacing element between the blade walls. Owing to the necessity of pressing together the surfaces to be welded together, a stay is positioned between the legs of the U before welding, after which each of the legs of the U is resistance-welded firmly to the blade from the outside of the blade wall. The stay is then removed from the blade. One disadvantage of this method is that it is relatively time-consuming to place the stay in the intended position and to remove it after welding has been carried out. It is also difficult to achieve sufficiently good quality. In structural terms, it is not an optimum solution, because stress concentrations tend to occur, the weld then not being sufficiently strong.

Other known welding methods for firmly welding a support element between the blade walls consist of electron beam welding and TIG welding. Both these welding techniques have proved to be associated with problems in the form of crack formation after being used for a time. Electron beam welding is also a relatively complicated and expensive method. At the edges, it is difficult to achieve complete fusion with fine transitions.

Another variant is what is known as diffusion bonding including superplastic forming. In this variant, use is in principle made of three plates which, in certain mutually separate areas, are interconnected. The connection is made by virtue of the plates being caused, in these areas, to diffuse into one another at

high temperature and high pressure. After this first processing phase, the construction is subjected to high internal pressure so that the desired geometry is obtained.

5

SUMMARY OF THE INVENTION

One object of the invention is to produce a method for connecting a support element to a blade wall which, in comparison with the prior art, results in a joint of
10 higher strength and/or more cost-effective manufacture.

This object is achieved by virtue of the fact that the support element is joined together with at least one of the blade walls by means of laser-welding from the
15 outside of the blade in such a way that the joined-together portions of the support element and the blade wall form a T-shaped joint. Suitable selection of material parameters and welding parameters makes it possible to obtain a T-shaped joint with rounded
20 corners, or at least a smooth transition between welded-together parts, inside the blade. This results in a high-strength construction and thus an extended life. Alternatively, a construction with thinner wall thicknesses and thus reduced weight can be obtained.

25

According to a preferred embodiment of the invention, said support element is arranged so that it extends essentially at right angles to the mean camber line of the blade. Mean camber line means a line which extends
30 halfway between the outer surface of an upper blade wall and the outer surface of a lower blade wall. Such an arrangement of the support element results in a construction of still higher strength.

35 According to another preferred embodiment of the invention, said support element has the shape of a plate. Plate shape means that the support element has two parallel side surfaces at a relatively short distance from one another. This is a simple shape in

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manufacturing terms, and thus a cost-effective construction element.

According to a development of the preceding embodiment,
5 the edge of the plate-shaped support element is connected to the blade wall. Edge means the elongate surface which connects the two side surfaces of the plate.

10 Further preferred embodiments and advantages of the invention emerge from the further subclaims and also the description below.

BRIEF DESCRIPTION OF FIGURES

15 The invention will be described in greater detail below with reference to the embodiments which are shown in the accompanying drawings, in which

FIG 1 shows a perspective view of a blade manufactured according to the invention, and

20 FIG 2 shows a cross-sectional view of a welded joint.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 1 shows a hollow blade 1 in a perspective view. The blade 1 has a first side wall 2 and a second side
25 wall 3 located opposite one another. The first side wall 2 has a convex cross-sectional shape, and the second side wall 3 has a concave cross-sectional shape. A mean camber line is indicated by a dot/dash line and designated by reference X. The mean camber line extends
30 centrally in the blade from a front end 4 of the blade to a rear end 5 of the blade. The front end and rear end are described in relation to the direction from which the gas flow is intended to act during use of the blade in a stator component or rotor component.

35

Furthermore, two plate-shaped support elements 6, 7 are arranged inside the blade 1. The plate-shaped support elements 6, 7 are arranged upright inside the blade 1 and extend essentially at right angles to the mean

- 5 -

camber line X. Each of the plate-shaped support elements 6, 7 is elongate and extends in the transverse direction of the blade 1, indicated here by a broken line Y.

5

The hollow blade 1 is manufactured in a conventional manner. The plate-shaped support elements 6, 7 are subsequently placed in their intended positions inside the blade, and then each of the support elements 6, 7 is laser-welded firmly to the walls 2, 3 from the outside of the blade. The laser-welding is carried out in such a way that the joined-together portions of the support element 6, 7 and the blade wall 2, 3 form a T-shaped joint 9 (see also Figure 2). In other words, the support element 6, 7 is concealed by the wall 2, 3 of the blade, seen from the outside of the blade wall, during welding.

More specifically, T-joint 9 means that a portion of the blade wall 3 forms the crosspiece part of the T, and a portion of the support element 6 forms the upright part of the T which joins the crosspiece part.

The materials used for the blade walls 2, 3 and the support elements 6, 7 consist of weldable materials, such as stainless steel, for example of the type 347 or A286. Use can alternatively be made of nickel-based alloys such as, for example, INCO600, INCO625, INCO718 and Hastaloy x. According to other variants, cobalt-based alloys, for example of the type HAYNES 188 and HAYNES 230, can be used. Titanium alloys, such as Ti6-4, and various types of aluminum alloys, can also be used. Combinations of different materials are also possible.

35

For the laser-welding, use is preferably made of an Nd:YAG-laser, but other types of welding arrangement, for example a CO₂-laser, can also be used according to the invention.

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By accurate matching of the welding procedure, material selection and dimensions of blade walls and support elements, the laser-welding produces the T-shape at the joint and also a softly rounded shape 8 on the inner corners between the support plate 6, 7 and the blade walls 2, 3. The thickness of the blade wall and the support element is preferably in the range 0.5-5 mm and in particular in the range 1-2 mm. Welding is suitably effected by means of a continuous weld. The rounded shape 8 of the welded joints results in a high-strength construction and thus a long life of the component.

According to an illustrative embodiment, use was made of the following parameters:

Wall thickness: 1.23 mm

Material: Ti6-4

Power: 1.3 kW

Welding speed: 1000 mm/min

Protective gas and root gas: argon

20

As an alternative or complement, use can be made of helium and/or oxygen and mixtures of these as protective gas and root gas.

25 In order that the welded joint comes to lie in exactly the correct position, a previously known joint-tracking technique can be used.

30 The invention is not to be regarded as being limited to the illustrative embodiment described above, but a number of further variants and modifications are conceivable within the scope of the patent claims which follow.

35 The invention is of course not limited to blades of the curving airfoil type, but can of course also be used for blades of the symmetrical airfoil type. In such a case, the mean camber line X mentioned above coincides with the symmetry line of the blade. The symmetry line

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of the blade coincides with the longitudinal direction of the blade, that is to say a straight line from its front edge to its rear edge in the intended gas-flow direction.

5

The invention is not to be regarded as being limited to manufacturing a blade for a gas turbine, but the method can be used for manufacturing blades for other applications, such as an aircraft wing. In such a case,

10 the stator component forms the aircraft wing.

According to the description above, said support element has the shape of a plate which is continuous in the transverse direction of the blade. Alternatively,

15 it would be possible to envisage a number of support elements in the form of struts or a framework forming the reinforcement between the two side walls.

PATENT CLAIMS

1. A method for manufacturing a hollow blade (1) intended for a stator component or rotor component, at least one support element (6, 7) being positioned
5 between two opposite blade walls (2, 3) and joined together with these, characterized in that the support element (6, 7) is joined together with at least one of the blade walls (2, 3) by means of laser-welding from the outside of the blade in such a way that the joined-
10 together portions of the support element and the blade wall form a T-shaped joint (9).

2. The method as claimed in claim 1, characterized in that said support element (6, 7) is arranged so that it
15 extends essentially at right angles to the mean camber line (X) of the blade (1).

3. The method as claimed in claim 1 or 2, characterized in that said support element (6, 7) has
20 the shape of a plate.

4. The method as claimed in claim 3, characterized in that the edge of the plate-shaped support element (6, 7) is connected to the blade wall.

25 5. The method as claimed in any one of the preceding claims, characterized in that the blade (1) with the hollow shape is manufactured first, in that the support element (6, 7) is subsequently positioned inside the
30 blade, and in that the support element is then welded firmly to the wall.

6. The method as claimed in any one of the preceding claims, characterized in that, in a cross section, the
35 outer contour of the blade (1) forms the shape of an airfoil.

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7. The method as claimed in any one of the preceding claims, characterized in that the stator component or rotor component is intended for a gas turbine.

5 8. The method as claimed in any one of the preceding claims, characterized in that the stator component or rotor component is intended for a jet engine.

9. The method as claimed in any one of claims 1-6,
10 characterized in that the stator component is intended to form at least part of an aircraft wing.

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B23K, B23P, B64C, B64F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DD 297097 A5 (ZIS HALLE GMBH), 2 January 1992 (02.01.92), page 2, line 8 - line 22 --	1,7
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A	US 5188281 A (CHIKARA FUJIWARA ET AL), 23 February 1993 (23.02.93), figures 1,2, abstract --	1

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Anders Brinkman/MP
Telephone No. +46 8 782 25 00

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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