(12) UK Patent Application (19) GB (11) 2 272 731 (13) A

(43) Date of A Publication 25.05.1994

(21) Application No 9321721.4

(22) Date of Filing 21.10.1993

(30) Priority Data
(31) 9213833 (32) 18.11.1992 (33) FR

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(51) INT CL[5]
F04D 29/38

(52) UK CL (Edition M)
F1V VCW V104 V404 V406
U1S S2005 S2006

(56) Documents Cited
GB 1446045 A GB 1410014 A GB 1404757 A
GB 1282250 A GB 1257041 A GB 1089247 A
GB 0989217 A GB 0910400 A GB 0895077 A
GB 0872705 A GB 0493255 A

(58) Field of Search
UK CL (Edition L) F1V VCAA VCW
INT CL[5] F01D 5/00 5/12 5/14 5/18 9/00 9/02 9/04 , F04D 29/00 29/38 29/40 29/44 29/52 29/54

(54) Hollow blade for the fan or compressor of a turbomachine

(57) In order to enhance rigidity and stress resistance, a hollow blade 1 for a turbomachine is formed by two outer skins (2) (fig. 5) connected by internal strengthening elements, such as ribs 5, 6, or bridging elements (11, 12, 13, figs 2, 3 and 4), arranged in two intersecting diagonal directions relative to the longitudinal and transverse directions of the blade. The thickness of the strengthening elements may be varied. The construction is stated to be particularly applicable to large chord fan blades.

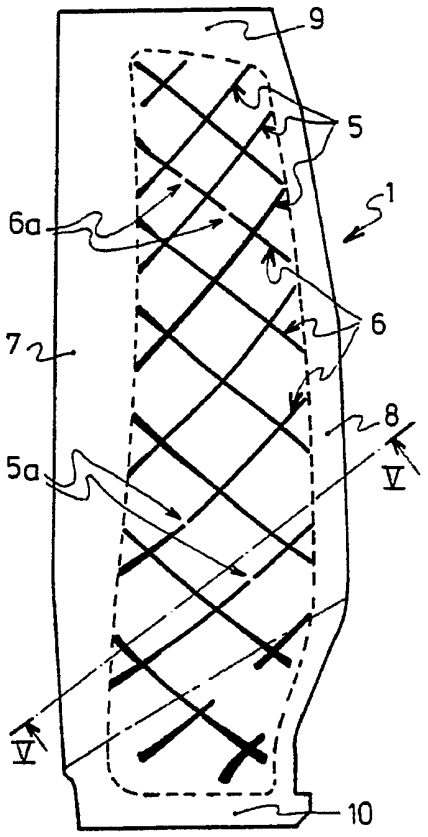

FIG : 1

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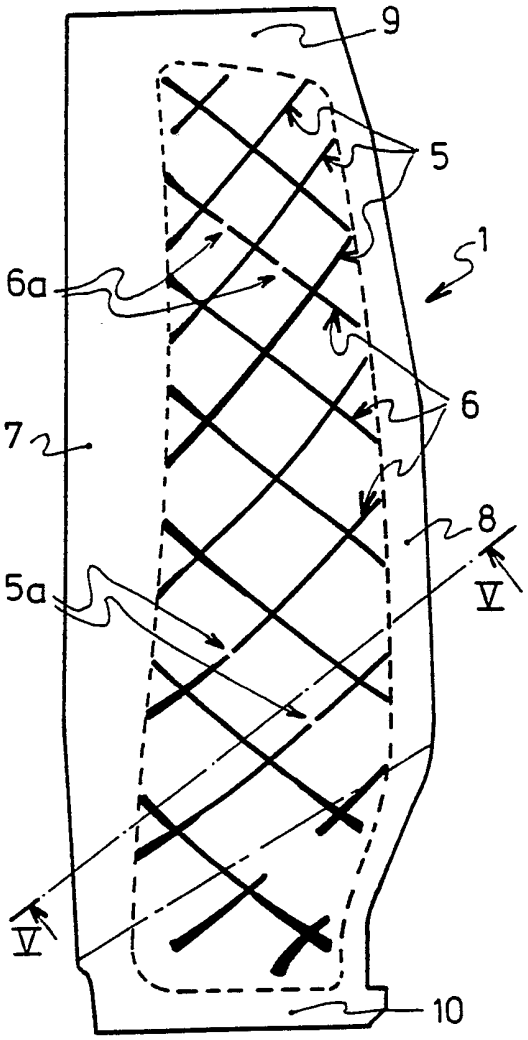

FIG : 1

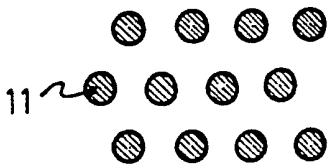

FIG : 2

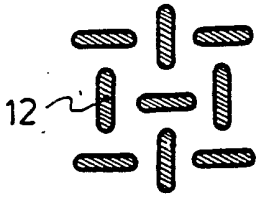

FIG : 3

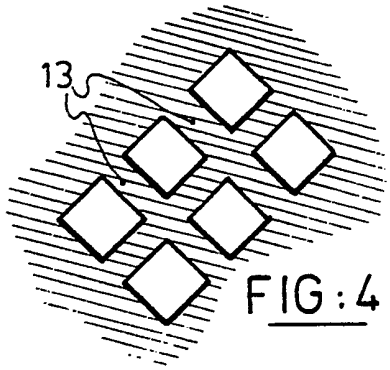

FIG : 4

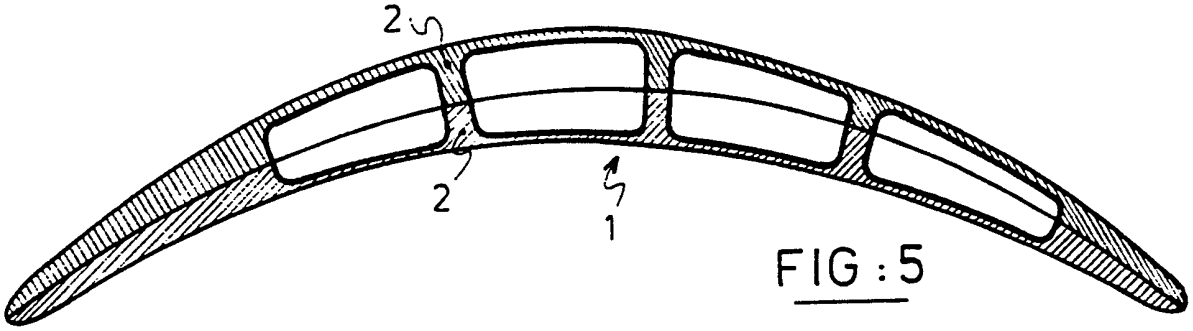

FIG : 5

HOLLOW BLADE FOR THE FAN OR COMPRESSOR OF A TURBOMACHINE

The present invention relates to a hollow blade for a turbomachine, and is particularly applicable to fan blades having a large chord.

The advantages of using large-chord blades for turbomachines have become apparent, particularly in the case of the fan rotor blades of turbojet bypass engines. These blades must cope with severe conditions of use and must, in particular, possess satisfactory mechanical characteristics associated with anti-vibration properties and resistance to impact by foreign bodies. However, the aim for sufficient speeds at the tip of the blade have led to research into reducing the mass, and in particular by using a hollow construction for the blade.

FR-A-1 577 388 discloses an example of a blade composed of two wall elements between which a honeycomb structure is arranged, these wall elements being constituted particularly of a titanium alloy and being formed with the desired profile and shape by hot pressing.

US-A-3 628 226 describes a process for manufacturing a hollow compressor blade comprising the implementation of metallurgical bonding by diffusion welding between two components or half-blades having a grooved flat mating face.

Other known techniques for obtaining hollow blades, particularly for the fan of a turbojet engine, combine the operations of welding by metallurgical diffusion under pressure and superplastic forming under gas pressure. An example is disclosed in US-A-4 882 823.

It is an object of the invention to obtain an improvement in the mechanical behaviour of a hollow blade, especially better resistance to shocks, by taking account of dynamic aspects and particularly by providing improved rigidity of the profile of the blade in the transverse direction and satisfactory resistance to mechanical stress as a function of the various modes of torsion experienced.

To this end, according to the invention there is provided a hollow blade for a turbomachine comprising two outer skins interconnected by internal strengthening elements arranged in at least two different intersecting directions which are diagonal in relation to the longitudinal and transverse directions of the blade, the

directions in which the strengthening elements are arranged being determined by optimisation as a function of the results of testing the blade for resistance to shocks, and dynamic aspects of the results of testing the mechanical behaviour of the blade.

The strengthening elements may be in the form of ribs or bridging members.

It can be advantageous for the strengthening elements to be formed by two parts connected together, each part being integral with one of the two skins.

Various embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a diagrammatic view of a hollow turbomachine blade in accordance with a first embodiment of the invention;

Figure 2 represents a diagrammatic partial sectional view, in a plane oriented along the longitudinal direction of the blade, of a hollow turbomachine blade in accordance with a second embodiment of the invention;

Figure 3 is a view similar to that of Figure 2, of a third embodiment of a hollow turbomachine blade in

accordance with the invention;

Figure 4 is a view similar to those of Figures 2 and 3, of a fourth embodiment of a hollow turbomachine blade in accordance with the invention; and,

Figure 5 is a diagrammatic transverse sectional view of a hollow turbomachine blade in accordance with the invention taken, for example, along the line V-V in Figure 1.

A hollow turbomachine blade in accordance with the invention, such as the large-chord fan blade 1 diagrammatically represented in Figure 1, is novel because of the means used to rigidify the outer skins 2 of the blade. In this first embodiment of the invention, the connecting strengthening elements between the skins 2 consist of criss-crossed ribs 5 and 6 arranged in two intersecting diagonal directions in relation to the longitudinal and transverse directions of the blade 1.

The production of these hollow blades uses manufacturing processes known in themselves. In particular, the ribs 5 and 6 may be obtained on the inner face of each of the outer skins 2 by, for example, chemical machining, part of each rib being integral with each skin. The two components thus obtained can then be connected by any assembly process leading to a metallurgical bond of these components, such as, for example, welding or brazing,

with or without associated intermetallic diffusion.

As shown in Figure 1, an area at the edge of the blade 1 is kept solid, particularly an area at the leading edge 7 which has to withstand impact by foreign bodies, especially when used in aero engines, and also in the regions of the trailing edge 8 and the upper end 9 and lower end 10 of the blade 1.

In order to comply with the mechanical performance requirements of the blade 1, particularly in its dynamic aspects, the distribution of mass can be modulated, particularly in the longitudinal direction of the blade 1, as is already well known to the person skilled in the art. Furthermore, in accordance with the invention, the density of the connections between the two outer skins 2 may vary according to the zones of the blade. This variation may be obtained by varying the thickness of the ribs 5 and 6.

Instead of producing continuous ribs, as provided in the two embodiments which have just been described with reference to Figure 1 of the drawings, the connecting strengthening elements between the outer skins 2 of the blade 1 may be broken and have the form of bridging members. Figures 3, 4 and 5 show three variant

embodiments of these bridging members 11, 12 and 13 in this form of the invention.

As before, the preferred directions can be retained either in the geometric definition of the bridging members 12, as in the variant in Figure 4, or in the alignment adopted in the arrangement of the bridging members, the associated preferred directions being two criss-crossed diagonal directions in a manner similar to the preceding embodiments of the invention described with reference to Figure 1.

The manufacture of the blade 1 calls for the same manufacturing processes as before and Figure 5 shows a diagrammatic representation of the assembly obtained in all cases, and in particular the connections produced between the outer skins 2.

It will be noted that the preferred directions of the arrangement of the connecting strengthening elements between the outer skins 2 of the blade 1 can be optimised as a function of the results of resistance calculations and the results of tests for the resistance of the blade to shocks, and tests of the blade's mechanical behaviour in its dynamic aspects.

Furthermore, in all cases where the production of ribs such as 5, 6 creates cavities which would be closed, communications such as those indicated at 5a or 6a in Figure 1 are made in order to avoid pressurisation.

CLAIMS

1. A hollow blade for a turbomachine, comprising two outer skins interconnected by internal strengthening elements arranged in at least two different intersecting directions which are diagonal in relation to the longitudinal and transverse directions of the blade, the directions in which the strengthening elements are arranged being determined by optimisation as a function of the results of testing the blade for resistance to shocks, and dynamic aspects of the results of testing the mechanical behaviour of the blade.

2. A hollow blade according to Claim 1, in which the strengthening elements are criss-crossed ribs arranged in two intersecting diagonal directions relative to the longitudinal and transverse directions of the blade.

3. A hollow blade according to Claim 1, in which the strengthening elements are formed by bridging members aligned in two intersecting diagonal directions relative to the longitudinal and transverse directions of the blade.

4. A hollow blade according to any one of Claims 1 to 3, in which the thickness of the strengthening elements

varies whereby the ratio of the area of the skins connected by the strengthening elements per unit area of the skins on the surface of the blade varies in different regions of the blade.

5. A hollow blade according to claim 1, substantially as described with reference to Figures 1 and 5, or as modified with reference to any one of Figures 2 to 4, of the accompanying drawings.

Examiner's report to the Comptroller under Section 17 (The Search report) 10

GB 9321721.4

Relevant Technical Fields

(i) UK Cl (Ed.L) F1V (VCAA, VCW)

(ii) Int Cl (Ed.5) F04D 29/00,29/38,29/40,29/44,29/52,29/54
F01D 5/00,5/12,5/14,5/18,9/00,9/02,9/04

Search Examiner
C B VOSPER

Date of completion of Search
22 DECEMBER 1993

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1 TO 5

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1446045	(GENERAL) Figure 3	1,3 and 4
X	GB 1410014	(ROLLS-) Figure 5 - page 1 line 88 to page 2 line 2	1 and 2
X	GB 1404757	(ROLLS-) Figures 1 and 2	1 and 2
X	GB 1282250	(GENERAL) Figure 6, page 1 lines 12 to 15, page 2 lines 98 to 118	1 to 3
X	GB 1257041	(ROLLS-) Figures 6 and 7, page 2 lines 9 to 33	1,3 and 4
X	GB 1089247	(ROLLS-) Figure 2 and Claim 6)	1,2
X	GB 989217	(GENERAL) page 1, lines 63 et seq eg Figures 3 and 8	1,3,4
X	GB 910400	(ENTWICK-) Figures 2 and 3	1,3,4
X	GB 895077	(ROLLS-) Figures 2 and 3	1,3
X	GB 872705	(GENERAL) Figures 6 and 8	1,3
X	GB 493255	(DORNIER) whole document	1,2

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).