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(54) Title: TURBINE BLADE

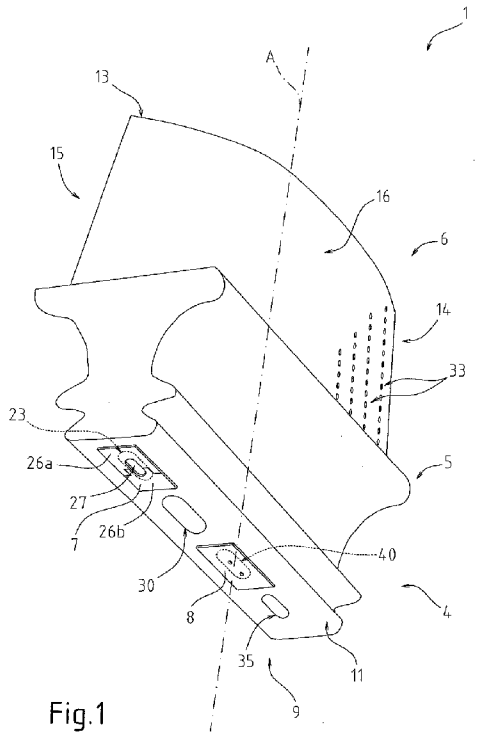

Fig.1

(57) Abstract: A turbine blade extends along a longitudinal axis (A) and is provided with: an anchoring portion (4) provided with a base face (11); a platform (5) integrally coupled to the anchoring portion (4); a main elongated body (6) which extends from the platform (5) on the opposite side with respect to the anchoring portion (4); a cooling circuit (9), which comprises a first cooling line (19) provided with a first inlet opening (23) arranged on the base face (11) of the anchoring portion (4) of the blade (1); and a metering plate (7) coupled to the base face (11) at the first inlet opening (23) and comprising a first portion (26a) and a second portion (26b) couplable to each other and shaped in such a way to define, together, an opening (27) having a variable section.

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TURBINE BLADE

TECHNICAL FIELD

The present invention relates to a turbine blade.

BACKGROUND ART

A known type of turbine blade extends along a longitudinal axis and comprises an anchoring portion, a platform integrally coupled to the anchoring portion, a main elongated body and a cooling circuit in which a cooling fluid, generally air, flows.

The air flow flowing in the cooling circuit removes heat by convection and lowers the temperature of the blade.

The cooling circuit comprises a first cooling line for cooling a trailing edge of the main body of the blade, a second cooling line for cooling a central portion of the main body of the blade, and third cooling line for cooling the leading edge of the main body of the blade.

The first cooling line comprises a first inlet opening arranged on a base face of the anchoring portion of the blade, a cooling duct which substantially extends over the whole length of the blade along the trailing edge of the main body of the blade, and a plurality of outlet slots arranged along the trailing edge of the blade.

Blades of this type further comprise a metering plate which is arranged at the first inlet opening on

the base face of the anchoring portion of the blade, so as to adjust the flow rate of air circulating in the first cooling line.

The metering plates of known type are generally provided with three holes dimensioned so as to determine the passage of a given flow rate of cooling fluid, calculated during the steps of designing.

However, it frequently occurs that the flow rate measured after applying the metering plate is not within the designed limits. Removing the metering plate and replacing it with a plate having differently dimensioned holes is thus needed, and sometimes modifying the cooling duct obtained by micro-casting is even needed when the holes of the metering plate are not enough to compensate the machining faults of the cooling duct.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a turbine blade which is free from the drawbacks of the prior art highlighted herein; in particular, it is an object of the present invention to provide a turbine blade which allows to overcome the drawbacks highlighted above in a simple, cost-effective manner, from the functional and constructional point of view.

In accordance with these objects, the present invention relates to a turbine blade extending along a longitudinal axis comprising:

an anchoring portion provided with a base face;

a platform integrally coupled to the anchoring

portion;

a main elongated body, which extends from the platform on the opposite side with respect to the anchoring portion, and comprises a trailing edge;

a cooling circuit, which comprises a first cooling line for cooling the trailing edge provided with a first inlet opening arranged on the base face of the anchoring portion of the blade; and

a metering plate coupled to the base face at the first inlet opening;

the blade being characterized in that the metering plate comprises a first portion and a second portion joinable to each other and shaped in such a way to define, together, an opening having a variable section.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will be apparent from the following description of a non-limitative embodiment thereof, with reference to the figures in the accompanying drawings, in which:

- figure 1 is a perspective view of a turbine blade according to the present invention;
- figure 2 is a side plan view, with parts in section and parts removed for clarity, of the turbine blade in figure 1;
- figure 3 is a bottom plan view of an element of the turbine blade in figure 1 in a first configuration;

– figure 4 is a bottom plan view of an element of the turbine blade in figure 1 in a second configuration.

BEST MODE FOR CARRYING OUT THE INVENTION

In figure 1, numeral 1 denotes a turbine blade (not shown in the accompanying drawings), which extends along an axis A and comprises an anchoring portion 4, a platform 5 integrally coupled to the anchoring portion 4, a main elongated body 6 which extends from the platform 5 on the opposite side with respect to the anchoring portion 4, a metering plate 7, a closing plate 8, and a cooling circuit 9 (shown in greater detail in figure 2).

The anchoring portion 4 may be inserted into a respective seat of a rotor disc (not shown in the accompanying drawings) in a direction parallel to the axis of the rotor disc, substantially orthogonally to axis A of blade 1. In particular, the anchoring portion 4 has a so-called "fir-tree" shape, substantially complementary with the shape of the respective seat of the rotor disc, but has a lower radial height than the radial height of the seat so that, once the seat is engaged, the anchoring portion 4 and the seat of the rotor disc create a channel (not shown for simplicity) for the passage of a cooling fluid, preferably air tapped from a compressor (not shown) of the system comprising the turbine.

The anchoring portion 4 of each blade 1 is provided

with a base face 11, which is adapted in use to face the above-described channel for the passage of the cooling fluid.

The main body 6 of blade 1 comprises a top section 13, commonly referred to as "tip", opposite to the anchoring portion 4, a leading edge 14, a trailing edge 15, and a central portion 16.

With reference to figures 1 and 2, the cooling circuit 9 comprises a first cooling line 19 for cooling the trailing edge 15 of the main body 6 of blade 1, a second cooling line 20 for cooling the central portion 16 of the main body 6 of blade 1, and a third cooling line 21 for cooling the leading edge 14 of the main body 6 of blade 1.

The first cooling line 19 comprises a first inlet opening 23 arranged on the base face 11 of the anchoring portion 4 of blade 1, a first cooling duct 24 which substantially extends parallel to axis A over the whole length of the blade 1 along the trailing edge 15 of the main body 6, and a plurality of outlet slots 25 arranged along the trailing edge 15 of blade 1.

A metering plate 7 is arranged at the first inlet opening 23 to adjust the flow rate of air circulating in the first cooling line 19.

With reference to figure 1, the metering plate 7 is defined by a first portion 26a and by a second portion 26b, each of which is shaped so that the first portion 26a and the second portion 26b jointly define an opening

27 having a variable section.

The coupling between the first portion 26a and the second portion 26b is of the geometric type and allows to couple the first portion 26a and the second portion 26b in a plurality of positions to define an opening 27 having a variable section.

Figure 3 shows a metering plate 7 in a first position in which the section of the opening 27 is minimum and equal to about 28% of the section of the first inlet opening 23.

Figure 4 shows a metering plate 7 in a second position in which the section of the opening 27 is maximum and equal to abut 38% of the section of the first inlet opening 23.

In use, the metering plate 7 is fixed to the base face 11 of the anchoring portion 4 of blade 1 in a given position corresponding to a given passage section of the opening 27.

The passage section 27 is calculated once the flow rate of the cooling air flowing in the first cooling line 19, without calibration plate 7, has been experimentally measured.

The metering plate 7 indeed corrects the error between the flow rate experimentally measured along the first cooling line 19 and the desired flow rate calculated during the steps of designing.

In essence, the metering plate 7 is mainly used to correct machining errors which are generated during the

step of forming the blade 1 by micro-casting and which determine a variation of the flow rate of the cooling fluid flowing in the first cooling line 19.

In use, the cooling fluid enters through the opening 27 of the metering plate 7 and through the first inlet opening 23 in the first cooling duct 24, and exits through the plurality of outlet slots 25 arranged along the trailing edge 15 of blade 1.

A variation (not shown) provides for the metering plate 7 being provided with reference notches adapted to indicate the plurality of positions which may be taken by the first portion 26a and the second portion 26b to define the opening 27.

With reference to figure 2, the second cooling line 20 comprises a second inlet opening 30 arranged on the base face 11 of the anchoring portion 4 of blade 1, a second cooling duct 31 arranged as a serpentine and substantially defined by three segments 32a, 32b, 32c parallel to axis A, and a plurality of outlet holes 33 arranged along the central portion 16 of the main body 6 of blade 1 (some of the outlet holes 33 are seen in figure 1).

In use, the cooling fluid enters through the second inlet opening 30 into the second cooling duct 31 and exits through outlet holes 33 arranged along the central portion 16 of the main body 6 of blade 1.

The third cooling line 21 comprises a third inlet opening 35 arranged on the base face 11 of the anchoring

portion 4 of blade 1, a third cooling duct 36 substantially parallel to axis A, and a plurality of film cooling holes 37 arranged along the leading edge 14 of the main body 6 of blade 1.

In use, the cooling fluid enters through the third inlet opening 35 into the third cooling duct 36 and exits through the film cooling holes 37 arranged along the leading edge 14 of the main body 6 of blade 1.

In the non-limiting example described and illustrated herein, the first inlet opening 23, the second inlet opening 30 and the third inlet opening 35 are eyelets defined by two rectilinear, parallel sidewalls and by two substantially circular sidewalls which join the two rectilinear sidewalls.

The base face 11 of the anchoring portion 4 is further provided with a service hole 40, which is closed by a closing plate 8 and is not used for cooling the blade 1.

The service hole 40 is indeed adapted to accommodate a supporting element (not shown) of the blade 1 during the process of forming the blade, preferably by micro-casting.

The service hole 40, the first inlet opening 23, the second inlet opening 30 and the third inlet opening 35 are aligned along the base face 11 of the anchoring portion 4 of blade 1.

It is finally apparent that changes and variations may be made to the turbine blade described herein

without departing from the scope of the appended claims.

CLAIMS

1. A turbine blade extending along a longitudinal axis (A) comprising:

an anchoring portion (4) provided with a base face (11);

a platform (5) integrally coupled to the anchoring portion (4);

a main elongated body (6) which extends from the platform (5) on the opposite side with respect to the anchoring portion (4) and comprises a trailing edge (15);

a cooling circuit (9), which comprises a first cooling line (19) for cooling the trailing edge (15) and is provided with a first inlet opening (23) arranged on the base face (11) of the anchoring portion (4) of the blade(1); and

a metering plate (7) coupled to the base face (11) at the first inlet opening (23);

the blade (1) being characterized by the fact that the metering plate (7) comprises a first portion (26a) and a second portion (26b) couplable to each other and shaped in such a way to define, together, an opening (27) having variable section.

2. A blade according to Claim 1, wherein the first portion (26a) and the second portion (26b) of the metering plate (7) are geometrically couplable in a plurality of positions for defining the opening (27) having variable section.

3. A blade according to Claim 2, wherein the first portion (26a) and the second portion (26b) are couplable in such a way to define an opening (27) having a minimum section equal to about 28% of the section of the first inlet opening (23) and a maximum section equal to about 38% of the section of the first inlet opening (23).

4. A blade according to Claim 1, wherein the first cooling line (19) comprises a first cooling duct (24), which is connected to the first inlet opening (23) and extends substantially parallel to the axis (A) for all the length of the blade (1) along the trailing edge (15) of the main body (6), and a plurality of outlet slots (25) arranged along the trailing edge (15) of the blade (1).

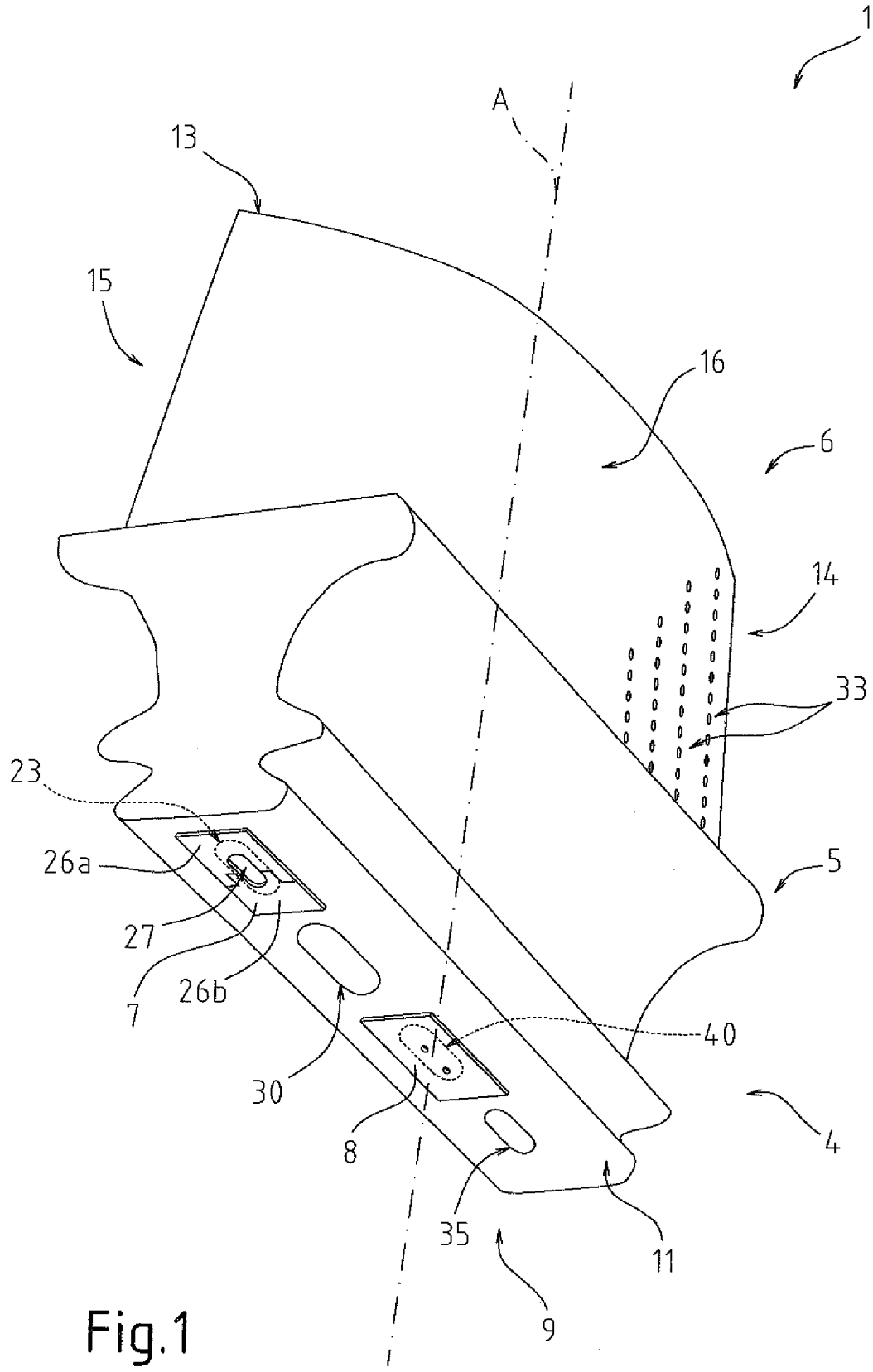

Fig.1

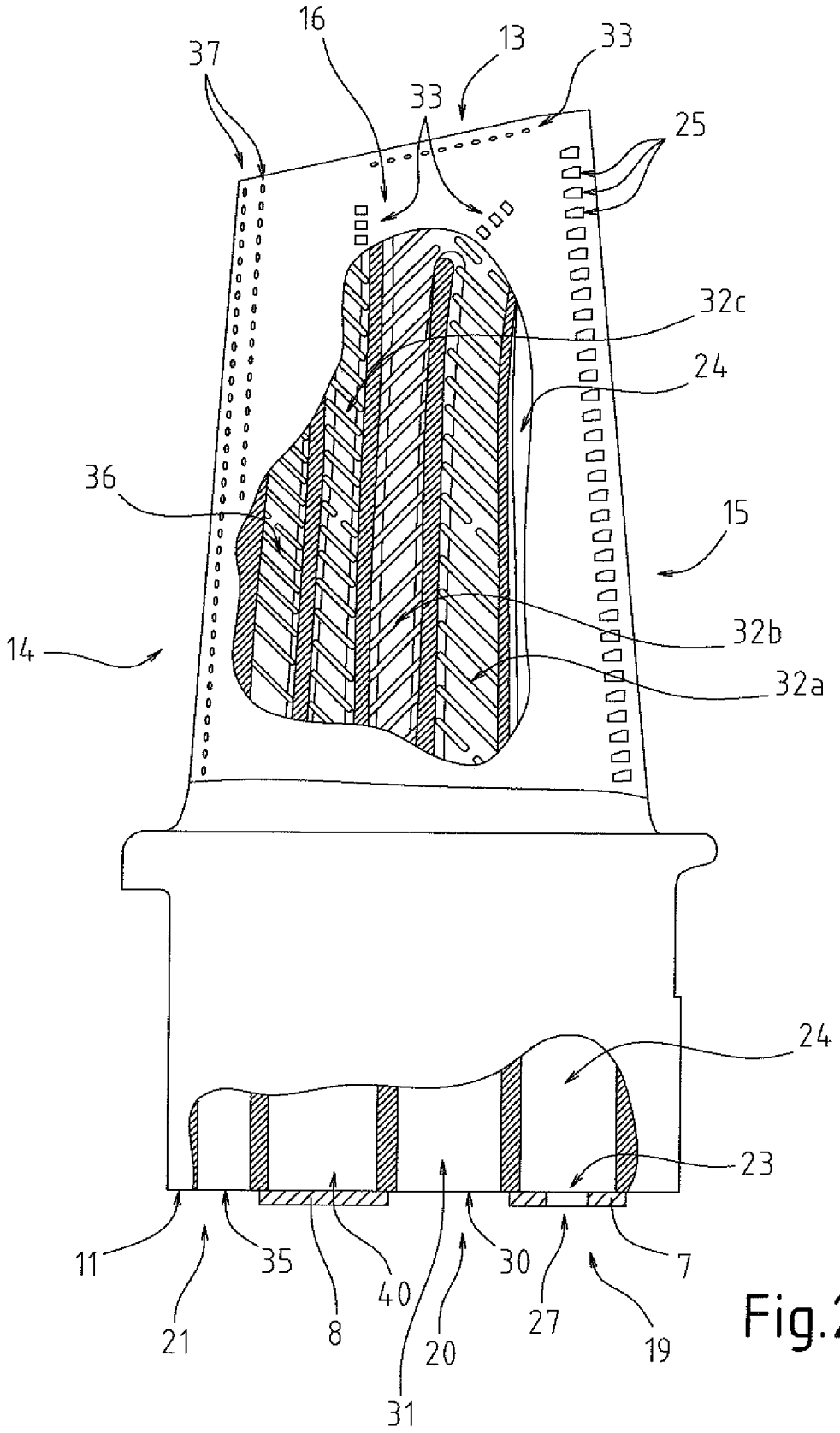
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Fig.2

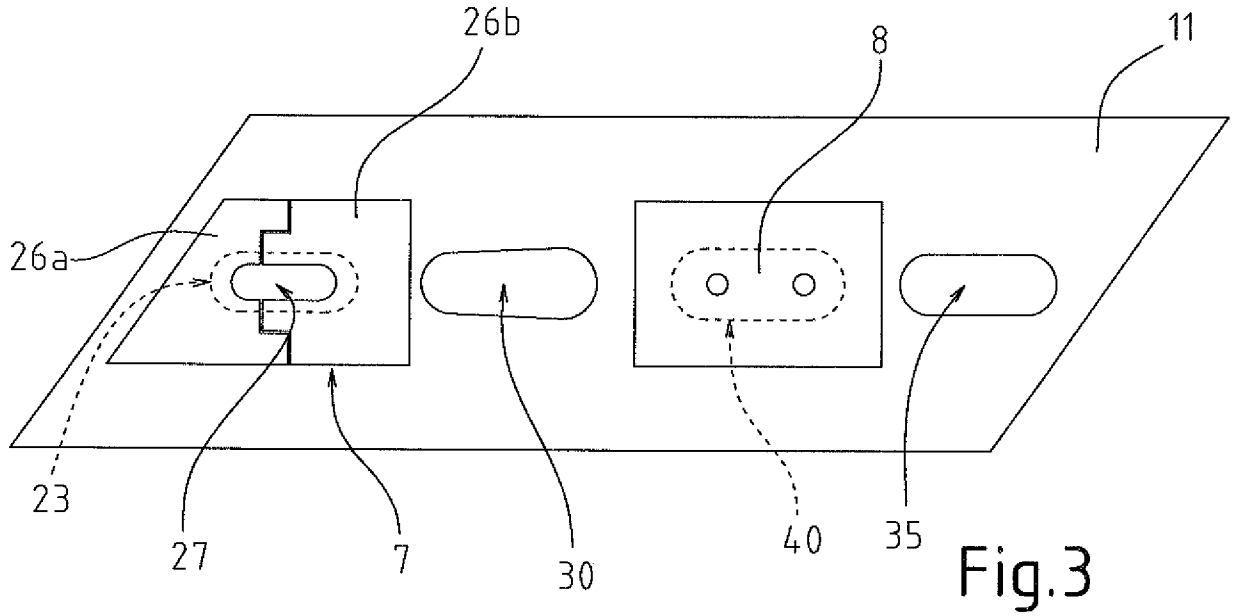

Fig.3

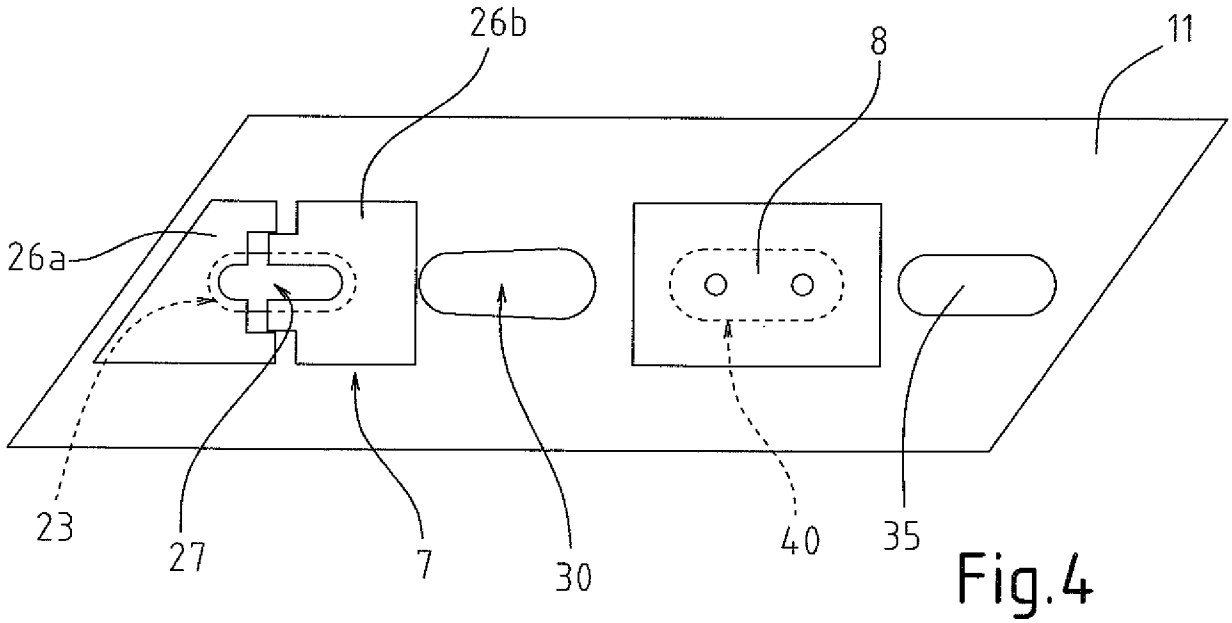

Fig.4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/057792

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01D5/08 F01D5/18
ADD.

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)
F01D

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/119045 A1 (STARKWEATHER JOHN HOWARD [US]) 29 August 2002 (2002-08-29) the whole document paragraphs [0019], [0022], [0023], [0026], [0027] figures 1,3	1-4
A	EP 1 942 251 A2 (GEN ELECTRIC [US]) 9 July 2008 (2008-07-09) the whole document paragraphs [0006], [0015], [0017] figures 1,2,9	1-4
A	EP 1 424 468 A2 (ROLLS ROYCE PLC [GB]) 2 June 2004 (2004-06-02) the whole document paragraphs [0010] - [0016] figure 1	1-4

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2010	24/08/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gombert, Ralf

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/057792

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 706 508 A (MOSKOWITZ SEYMOUR ET AL) 19 December 1972 (1972-12-19) the whole document column 2, lines 3-36 column 2, line 56 - column 4, line 29 figures 1-3 -----	1-4
X,P	WO 2010/046584 A1 (SNECMA [FR]; GROHENS REGIS [FR]; ROYAN RENAUD GABRIEL CONSTANT [FR]) 29 April 2010 (2010-04-29) the whole document page 4, line 3 - page 5, line 18 figures 1-3 -----	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2010/057792

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