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HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR,  
KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,  
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PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,  
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,  
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(54) Title: CERAMIC MATRIX COMPOSITE AIRFOIL COOLING

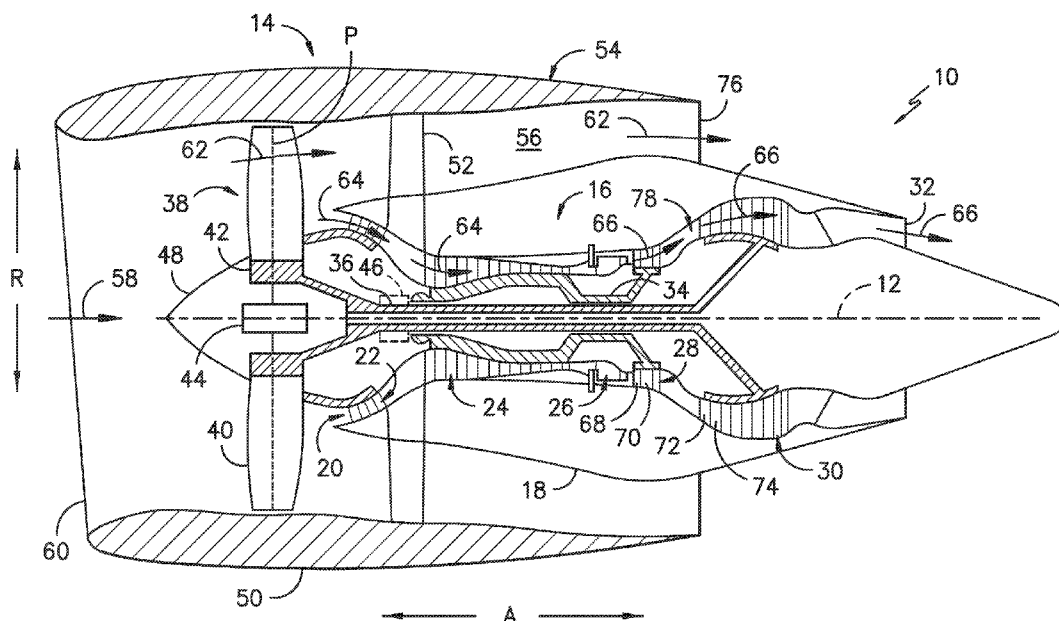


FIG. -1-

(57) Abstract: Ceramic matrix composite airfoils for gas turbine engines are provided. In an exemplary embodiment, an airfoil includes opposite pressure and suction sides extending radially along a span. The pressure and suction sides define an outer surface of the airfoil. The airfoil further includes opposite leading and trailing edges extending radially along the span, the pressure and suction sides extending axially between the leading and trailing edges. The airfoil also includes a filler pack defining the trailing edge; the filler pack comprises a ceramic matrix composite material. Moreover, the airfoil includes a plenum defined within the airfoil for receiving a flow of cooling fluid, and a cooling passage defined within the filler pack for directing the flow of cooling fluid from the plenum to the outer surface of the airfoil. Methods for forming airfoils for gas turbine engines also are provided.



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**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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A. CLASSIFICATION OF SUBJECT MATTER  
INV. F01D5/18 F01D5/14  
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 practicable, search terms used)  
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | EP 1 126 135 A2 (GEN ELECTRIC [US])<br>22 August 2001 (2001-08-22)<br>paragraphs [0046] - [0055]<br>figures 7-10               | 1-20                  |
| A         | US 2005/238491 A1 (MORRISON JAY A [US] ET AL)<br>27 October 2005 (2005-10-27)<br>paragraphs [0013] - [0020]<br>figures 1-6     | 1-20                  |
| A         | EP 0 978 634 A1 (D ETUDE SOC NAT [FR])<br>9 February 2000 (2000-02-09)<br>figures 2,3  | 1-20                  |
| A         | EP 1 367 223 A2 (SIEMENS WESTINGHOUSE POWER [US])<br>3 December 2003 (2003-12-03)<br>paragraphs [0021] - [0031]<br>figures 1-5 | 1-20                  |

Further documents are listed in the continuation of Box C.

See patent family annex.

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| Name and mailing address of the ISA/<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Authorized officer<br><b>Calabrese, Nunziante</b> |
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |            |
|--|------------------|-------------------------|------------------|------------|
| EP 1126135                             | A2               | 22-08-2001              | DE 60028529 T2   | 28-12-2006 |
|  |                  |                         | EP 1126135 A2    | 22-08-2001 |
|  |                  |                         | JP 4883834 B2    | 22-02-2012 |
|  |                  |                         | JP 2001227302 A  | 24-08-2001 |
|  |                  |                         | US 6325593 B1    | 04-12-2001 |
| -----                                  |                  |                         |                  |            |
| US 2005238491                          | A1               | 27-10-2005              | CA 2563824 A1    | 18-05-2006 |
|  |                  |                         | EP 1768893 A2    | 04-04-2007 |
|  |                  |                         | US 2005238491 A1 | 27-10-2005 |
|  |                  |                         | WO 2006052278 A2 | 18-05-2006 |
| -----                                  |                  |                         |                  |            |
| EP 0978634                             | A1               | 09-02-2000              | CA 2281965 A1    | 15-03-2001 |
|  |                  |                         | EP 0978634 A1    | 09-02-2000 |
|  |                  |                         | FR 2782118 A1    | 11-02-2000 |
|  |                  |                         | JP 3913938 B2    | 09-05-2007 |
|  |                  |                         | JP 2001098903 A  | 10-04-2001 |
|  |                  |                         | US 6328531 B1    | 11-12-2001 |
| -----                                  |                  |                         |                  |            |
| EP 1367223                             | A2               | 03-12-2003              | CA 2430457 A1    | 30-11-2003 |
|  |                  |                         | EP 1367223 A2    | 03-12-2003 |
|  |                  |                         | US 2003223861 A1 | 04-12-2003 |
|  |                  |                         | US 2004043889 A1 | 04-03-2004 |
| -----                                  |                  |                         |                  |            |