Title: BRAZED IN HEAT TRANSFER FEATURE FOR COOLED TURBINE COMPONENTS

FIG. 3

Abstract: A cooled turbine component in a turbine engine is provided. The cooled turbine component includes a brazed in heat transfer feature, the brazed in heat transfer feature including a thin film including a heat transfer feature incorporated into a surface of the film. The thin film is capable of conforming to a surface of the cooled turbine component and is attached to the surface of the cooled turbine component via a braze material. A method for cooling a turbine component in a turbine engine is also provided.
Published:
— with international search report (Art. 21(3))
BRAZED IN HEAT TRANSFER FEATURE FOR COOLED TURBINE COMPONENTS

BACKGROUND

1. Field

[0001] The present application relates generally to gas turbines, and more particularly to a brazed in heat transfer feature for cooled turbine components.

2. Description of the Related Art

[0002] Hot gas path components, such as blades and vanes of gas turbine engines, are typically exposed to high thermal loads during gas turbine operation. A flow of a hot gas is generated when a mixture of compressed air and a fuel are ignited in a combustor section of the gas turbine. The hot gas flows into the turbine section, which includes the blades and vanes. The temperatures to which the blades and vanes are exposed due to the flow of hot gas may be upwards of 450° C and possibly even as high as 1400-1600° C in the flow path.

[0003] The heat transfer rate and cooling effectiveness between cooling fluids and hot gas path components in a gas turbine engine directly correlates to the overall efficiency of the gas turbine. The more efficiently that heat is removed from the component, the higher the overall efficiency that can be achieved.

[0004] Various conventional methods are used to cool hot gas path components. Cast in heat transfer features, impingement cooling of backside hot gas path surfaces, and multi-circuit cooling passages are some of the methods in use to improve hot component cooling.

[0005] A gas turbine component’s ability to transfer heat away from itself is particularly important due to the high operating temperatures of the engine. One way to enhance the cooling capability is to increase the component’s surface area through the incorporation of heat transfer features. The incorporation of heat transfer features
within hot gas path components is typically limited by available casting technologies. Additionally, the features that can be cast in to the component add considerable cost and complexity to the casting process.

[0006] Consequently, a more versatile and inexpensive heat transfer feature and method to incorporate heat transfer features onto gas turbine hot gas components over the current casting process is desired.

SUMMARY

[0007] Briefly described, aspects of the present disclosure relates to a cooled turbine component in a turbine engine and

[0008] A cooled turbine component in a turbine engine is provided. The turbine component is one which requires cooling at least during operation of the turbine engine. The cooled turbine component includes a brazed in heat transfer feature, the heat transfer feature comprising a thin film including a heat transfer feature incorporated into a surface of the thin film. The thin film is capable of conforming to a surface of the cooled turbine component. The film is attached to the surface of the cooled turbine component via a braze material.

[0009] A cooled turbine vane assembly is provided. The cooled turbine vane assembly includes a turbine vane in a turbine engine comprising an elongated hollow airfoil, the airfoil including an outer wall and an inner wall requiring cooling at least during operation of the turbine engine and a vane insert inserted into a hollow pocket of the airfoil and fixed to the inner wall. A thin film including a heat transfer feature incorporated into a surface of the film is attached to the surface of the turbine vane via a braze material, the thin film conforming to a surface of the turbine vane. The heat transfer feature directs a flow of air to the exterior of the turbine vane in order to improve the heat transfer from the turbine vane.

[0010] A method for cooling a turbine component in a turbine engine is provided. The method includes providing a turbine component having a component surface and then brazing a thin film comprising a heat transfer feature on the component surface
via a braze material. The heat transfer feature captures heat generated during turbine operation when the turbine component is exposed to a flow of a hot gas thereby cooling the turbine component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 illustrates an embodiment of a thin film including heat transfer features,

[0012] Fig. 2 illustrates a perspective view of a vane assembly including a vane insert, and

[0013] Fig. 3 illustrates a cross section of a vane including an embodiment of a thin film including heat transfer features.

DETAILED DESCRIPTION

[0014] To facilitate an understanding of embodiments, principles, and features of the present disclosure, they are explained hereinafter with reference to implementation in illustrative embodiments. Embodiments of the present disclosure, however, are not limited to use in the described systems or methods.

[0015] The components and materials described hereinafter as making up the various embodiments are intended to be illustrative and not restrictive. Many suitable components and materials that would perform the same or a similar function as the materials described herein are intended to be embraced within the scope of embodiments of the present disclosure.

[0016] Brazing may be defined as a process that produces a coalescence of two or more materials by heating them to a temperature in the presence of a filler material, the filler material having a lower melting point than the materials to be joined. Thus, the filler liquidates at a lower temperature than the materials to be joined adequately covering the mating surfaces of said materials in order to form a permanent bond. In
contrast to welding, brazing allows bonding with the surface of another material without melting the base metal. The ability to braze onto high temperature components has improved significantly in recent years making brazing a more ideal way to incorporate heat transfer features onto a cooled turbine component. For example, the materials that one can braze with have increased such as improved powder compositions with filler materials. Brazing performs well for high temperature components as the melting point of a filler material may be well below that of the high temperature component which, in the case of high temperature components such as superalloy materials, it may be beneficial not to melt the component so that the integrity of the base metal of the high temperature component is maintained.

[0017] Referring now to the figures, where the showings are for purposes of illustrating embodiments of the subject matter herein only and not for limiting the same, Figure 1 illustrates an embodiment of a thin film 10 or sheet in which a plurality of heat transfer features 20 are incorporated. The thin film 10 including the heat transfer features 20 may be utilized for cooling of a component. The component may be a gas turbine component, for example, which is exposed to a flow of hot gases during turbine operation. In an embodiment, the film 10 may be capable of conforming to a surface of the component. Attaching the thin film 10 to a surface of the component may be accomplished via a braze process.

[0018] The thickness (t) of the film, which distinguishes the film as a thin film, is the thickness which allows the thin film to be flexible enough to conform to the surface to which it is being attached. The film thickness (t) will vary with the stiffness of the surface material of the component, the minimum braze thickness needed for bonding, and the geometry of the surface the film is being bonded to. The film thickness (t), measuring from the base of the heat transfer features to the surface of the component, may lie in a range of 0.1-5 mm. These thicknesses are for exemplary purposes only and are not meant to be limiting.

[0019] In the illustrated embodiment, the plurality of heat transfer feature(s) 20 includes a pin-shape and are formed into an array on the surface of the film 10. However, the heat transfer features 20 may be a variety of shapes according to the
cooling requirements of a component onto which the film 10 may be attached. For example, the shape of the heat transfer feature(s) may include pins, waves, chevrons, spikes, ribs, and fins. These listed shapes are for exemplary purposes only and are not meant to be limiting.

5

[0020] Because the film 10 including the heat transfer feature 20 is a separate component and attached to, as opposed to cast into, the component, the heat transfer feature 20 may be customized for the particular component it will be attached to and the cooling requirements of the component. Additionally, interchanging the brazed film with the heat transfer feature is relatively easy, for example by simply removing the thin film 10 from the turbine component. Having this capability, the heat transfer feature 20, may be optimized for the design of the turbine component and operating environment to which the turbine component is exposed.

10

[0021] The optimization of the heat transfer feature 20 may be accomplished using a variety of means, only a few of which will be discussed here. In an embodiment, the optimization may take the form of varying the shape and/or size of the heat transfer feature 20. For example, a single heat transfer feature 20 or a plurality of heat transfer features 20 may be incorporated onto the thin film 10. The shape of the heat transfer feature 20 may be selected from various shapes. In addition to the shapes discussed above, one skilled in the art would understand that a multitude of other shapes and sizes may be available for the optimization of the heat transfer feature. In another embodiment, the spacing between the plurality may be varied. In a further embodiment, the material of the thin film 10 may be varied according to the design requirements of the component onto which the thin film 10 will be attached. In a further embodiment, the location of the heat transfer feature on the thin film 10 may be varied to optimize the heat transfer of the turbine component.

15

[0022] In an embodiment, the cooled turbine component may be a turbine component such as blade, vane, or vane insert. However, the cooled turbine component may also be other turbine components such as a ring segment, combustion basket, combustion transition, etc. Vane inserts may be fixed to an inner surface of a hollow vane airfoil in order to facilitate the cooling of the vane.

20

[0023]
[0023] Referring to Figure 2, a turbine component for a gas turbine engine is shown in the form of a stationary turbine vane 30. The vane 30 includes an elongated airfoil having a body 35 with an outer wall 34 and an inner wall 33 (Figure 3). The vane 30 may also include an outer shroud 39 at a first end of the vane 30 and an inner shroud 38, also known as a platform, at a second end of the vane 30. The vane 30 may be configured for use in a gas turbine engine. The body 35 of the vane may define one or more hollow pockets 37 to allow for a cooling fluid to flow therethrough for cooling of the vane 30. The illustrated vane 30 includes a vane insert 40 in accordance with an embodiment. For ease of description, it is appreciated that although the singular term ‘insert’ is used, the term ‘insert’ may refer to one or more inserts. The insert 40 may be inserted into a hollow pocket 37 on the interior of the vane 30 as illustrated. In the embodiment shown in Figure 2, the thin film 10 will be attached to the inner wall 33 of the vane 30. In an alternate embodiment, the thin sheet 10 may be attached via a braze to an outer surface of the vane insert 40 across from the inner wall 33 of the vane.

[0024] Figure 3 shows a cross-sectional view of the airfoil 35 of the vane shown in Figure 2. As shown, the body of the airfoil 35 includes an outer wall 34 and an inner wall 33. Two hollow pockets 37 are shown in the interior of the vane separate by a rib 41. Vane inserts 40 may be inserted, as shown, into these hollow pockets 37. Figure 3 also depicts a thin film 10 attached to a surface of the inner wall 33 of the vane 30 between the vane 30 and the insert 40. The thin film 10 may be attached to the inner wall 33 via a braze material. In the shown embodiment, the thin film 10 conforms to the surface of the curved inner wall 33 of the vane. The heat transfer feature 20 incorporated onto the thin film 10 is depicted as spikes of various heights from a surface of the thin film 10 extending into the interior of the hollow pocket 37. During turbine operation, air flowing through the hollow pockets 37 is directed to an outer portion of the vane 30 by the heat transfer features 20 in order to improve the heat transfer of the vane 30.

[0025] In an embodiment, the thin film 10 may be any material that may be formed in a sheet. In another embodiment, the thin film 10 may be a material that is the same material or a similar material as that of a cooled turbine component, such as a turbine blade or vane. Cooled turbine components may be formed from a superalloy or
nickel-based alloy, such as CM 247, IN939, IN617, IN735, IN718, IN625, Haynes282, Haynes 230, Hast-X, and Hast-W. More generally, any material that can be brazed may be used for the cooled turbine component. Thus, by brazing in the heat transfer features 20 onto the turbine component 30, 40 to be cooled, the type of material used for the heat transfer feature 20 may be varied depending on the thermal conductivity of the heat transfer feature 20.

[0001] In an embodiment, the braze mixture including both the parent material to be joined and the filler material may include ratios of high melt parent material to low melt constituents. Some low melt constituents that may be used are Amdry™775, Co22, Co33, Bf4B, and BRB. The high melt to low melt values may vary from 10/90 (in wt. %) mixtures up to and including 90/10 (in wt. %) mixtures. The high melt to low melt values may vary from 10/90 (in wt. %) mixtures up to and including 90/10 (in wt. %) mixtures.

[0002] In an embodiment, the thin film 10 may be formed by various processes including welding heat transfer features 20 on a sheet of material, additive manufacturing, rolling, stamping, machining, water jetting, laser machining, convention machining, and non-conventional machining (EDM, ECM) and casting the thin film 10 with the incorporated features.

[0003] Referring to Figures 1-3, a method for cooling a turbine component 30, 40 is also provided. The method includes the steps of providing a turbine component 30, 40 having a component surface as described above. A thin film 10 including a heat transfer feature 20 is brazed onto the turbine component surface via a braze process. The heat transfer feature 20 captures heat generated during gas turbine operation when the turbine component 30, 40 is exposed to a flow of a hot gas thereby cooling the turbine component 30, 40.

[0004] In addition to the proposed means to optimize the thin film 10 including the heat transfer feature 20 as described above, the heat transfer feature 20 may be optimized according to the velocity of the hot gas flow and the temperature of the hot gas flow around the turbine component 30, 40.
In an embodiment, the proposed method may be utilized to retrofit an existing installed turbine component 30, 40. For example, in order to add heat transfer features 20 to a turbine component 30, 40 already installed in a gas turbine, the component 30, 40 may only need to be removed and the method performed on the turbine component in order to enhance the turbine component by adding heat transfer features optimized for the particular turbine component and the specific operating conditions the turbine component will be exposed to during turbine operation.

In a further embodiment, the proposed method may be used to interchange a currently brazed thin sheet 10 on a turbine component 30, 40 with another thin sheet having different heat transfer features 20 than the current one. The interchange may be accomplished by first removing the currently brazed thin sheet 10. Removing the currently brazed thin sheet 10 may entail heat treating the brazed thin sheet 10 in which the braze melts while the thin sheet material does not. The heat treatment chosen will be based on the particular filler material and component material used. The temperature for the heat treatment will be above the original brazing temperature. The thin sheet 10 may then be removed from the turbine component 30, 40. Another brazed thin sheet 10 having different heat transfer features 20 may then be brazed onto the turbine component 30, 40 according to the proposed method.

The proposed component and method offer the advantage of improved heat transfer capability of the component by the ability of optimizing the heat transfer features for the cooling requirements of the particular turbine component. Because the heat transfer features are not permanently cast into the component, the heat transfer features may be changed as the cooling requirements change, for example. Additionally, existing components may be retrofit with the brazed film during repair. Furthermore, brazing the heat transfer features onto the turbine component instead of casting is a more inexpensive option for the incorporation of heat transfer features onto a turbine component.

While embodiments of the present disclosure have been disclosed in exemplary forms, it will be apparent to those skilled in the art that many modifications, additions, and deletions can be made therein without departing from the spirit and scope of the invention and its equivalents, as set forth in the following
claims.
What is claimed is:

1. A cooled turbine component in a turbine engine, comprising:
   a turbine component 30, 40 requiring cooling at least during operation of the turbine engine;
   a brazed in heat transfer feature 20, comprising:
   a thin film 10 including a heat transfer feature 20 incorporated into a surface of the film 10, the film 10 capable of conforming to a surface of the cooled turbine component,
   wherein the film 10 is attached to the surface of the cooled turbine component via a braze material.

2. The cooled turbine component as claimed in claim 1, wherein the heat transfer feature 20 is optimized for the design of the cooled turbine component and its particular cooling requirements.

3. The cooled turbine component as claimed in claim 2, further comprising a plurality of heat transfer features 20.

4. The cooled turbine component as claimed in claim 3, wherein heat transfer feature is optimized by methods selected from the group consisting of:
   varying the shape of the heat transfer feature 20,
   varying the size of the heat transfer feature 20,
   varying the spacing between the plurality of heat transfer features 20,
   varying the type of material used for the heat transfer feature 20,
   varying a location of the heat transfer feature 20 on the surface of the cooled turbine component, and
   combinations thereof.

5. The cooled turbine component as claimed in claim 4, wherein the shape of the heat transfer feature is selected from the group consisting of pins, waves, chevrons, spikes, ribs, and fins.
6. The cooled turbine component as claimed in claim 1, wherein the cooled turbine component is selected from the group consisting of a turbine blade, turbine vane 30, and a vane insert 40.

7. The cooled turbine component as claimed in claim 6, wherein the cooled turbine component is a vane insert 40 and the film 10 is attached via a braze material to an outer surface of the vane insert 40.

8. The cooled turbine component as claimed in claim 1, wherein the thin film 10 including the heat transfer feature 20 is formed by a process selected from the group consisting of additive manufacturing, welding, casting, rolling, stamping, machining, water jetting, and conventional machining, non-conventional machining, and laser machining.

9. The cooled turbine component as claimed in claim 1, wherein a thickness of the thin film 10 is in a range of 1 mm to 5 mm.

10. The cooled turbine component as claimed in claim 3, wherein the plurality of heat transfer features 20 is formed in an array on the surface of the film 10.

11. A cooled turbine vane assembly, comprising:
   a turbine vane 30 in a turbine engine comprising an elongated hollow airfoil 35, the airfoil 35 including an outer wall 34 and an inner wall 33 requiring cooling at least during operation of the turbine engine;
   a vane insert inserted into a hollow pocket of the airfoil and fixed to the inner wall,
   a thin film 10 including a heat transfer feature 20 incorporated into a surface of the film 10, the film 10 conforming to a surface of the turbine vane 30, wherein the film 10 is attached to the surface of the cooled turbine vane via a braze material, and
   wherein the heat transfer feature 20 directs a flow of air to the exterior of the turbine vane 30 in order to improve the heat transfer from the turbine vane 30.
12. The cooled turbine vane assembly as claimed in claim 11, wherein the heat transfer feature 20 is optimized for the design of the turbine vane 30 and its particular cooling requirements.

13. The cooled turbine vane assembly as claimed in claim 11, further comprising a vane insert 40 inserted into a hollow pocket 37 of the airfoil 35 and attached to a platform of the turbine vane 30, wherein the film 10 is attached via the braze material to a surface of the inner wall between the turbine vane 30 and the vane insert 40.

14. The cooled turbine vane assembly as claimed in claim 13, wherein the vane insert includes a plurality of holes, the plurality of holes directing the flow of air across the heat transfer feature of the thin film.

15. A method for cooling a turbine component 30, 40 in a turbine engine, comprising:
   providing a turbine component 30, 40 having a component surface; and
   brazing a thin film 10 comprising a heat transfer feature 20 on the component surface via a braze material,
   wherein the heat transfer feature 20 captures heat generated during turbine operation when the turbine component 30, 40 is exposed to a flow of a hot gas, thereby cooling the turbine component 30, 40.

16. The method as claimed in claim 15, further comprising optimizing the heat transfer feature 20 for the design of the turbine component 30, 40 and its particular design requirements.

17. The method as claimed in claim 16, wherein the heat transfer feature 20 is optimized according to a velocity of the hot gas flow and the temperature of the hot gas flow around the turbine component 30, 40.

18. The method as claimed in claim 15, wherein the method is performed to retrofit the thin film 10 onto an installed turbine component 30, 40.
19. The method as claimed in claim 15, further comprising removing the brazed film 10 from the turbine component 30, 40 by heat treating the existing brazed film 10 and replacing the removed brazed film 10 with a further thin film via brazing.

20. The method as claimed in claim 15, wherein the cooled turbine component is selected from the group consisting of a turbine blade, turbine vane 30, and a vane insert 40.
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/US2017/064133

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. F01D5/18 F01D25/12

**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**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>GB 2 365 932 A (ROLLS ROYCE PLC [GB]) 27 February 2002 (2002-02-27) page 1, lines 4,5 page 5, line 2 - line 5 page 6, line 5 - line 8 page 7, line 7 - line 21</td>
<td>1-4, 6-13, 15 5</td>
</tr>
<tr>
<td>Y</td>
<td>abstract; figures 2-7 page 1, lines 4,5 page 5, line 2 - line 5 page 6, line 5 - line 8 page 7, line 7 - line 21</td>
<td>1-4, 6-13, 15 5</td>
</tr>
<tr>
<td>X</td>
<td>EP 3 118 420 A1 (SIEMENS AG [DE]) 18 January 2017 (2017-01-18) paragraphs [0005], [0030]; figures 1, 5</td>
<td>1-4, 6-13, 15 5</td>
</tr>
<tr>
<td>X</td>
<td>US 4 026 659 A (FREEMAN JR WILLIAM R) 31 May 1977 (1977-05-31) column 3, line 41 - line 68; figure 1</td>
<td>15-20 1-4, 6-13, 15</td>
</tr>
</tbody>
</table>

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

*Special categories of cited documents:

- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier application or patent but published on or after the international filing date
- **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- **O** document referring to an oral disclosure, use, exhibition or other means
- **P** document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"A" document member of the same patent family

Date of the actual completion of the international search

23 July 2018

Date of mailing of the international search report

30/07/2018

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

Klados, Iason
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>EP 1 149 982 A2 (GEN ELECTRIC [US]) 31 October 2001 (2001-10-31) paragraphs [0003], [0004], [0005], [0009]; figures 1-3</td>
<td>1-4, 6, 8-12</td>
</tr>
<tr>
<td>A</td>
<td>EP 1 956 192 A2 (UNITED TECHNOLOGIES CORP [US]) 13 August 2008 (2008-08-13) paragraphs [0019], [0020], [0021]; figures 4, 5</td>
<td>1-20</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>GB 2365932 A</td>
<td>27-02-2002</td>
<td>GB 2365932 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2002028 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 3292279 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2018195409 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 201709420 A1</td>
</tr>
<tr>
<td>US 4026659 A</td>
<td>31-05-1977</td>
<td>NON E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CZ 20003920 A3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 600370 10 T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1149982 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2001295604 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20010096524 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6453557 B1</td>
</tr>
<tr>
<td>EP 0091799 A2</td>
<td>19-10-1983</td>
<td>AR 23032 1 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 1201983 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3377373 D1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0091799 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IT 1194562 B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP HöI 12921 B2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP SM687502 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4482295 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2016102563 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2015023338 A2</td>
</tr>
<tr>
<td>US 5361828 A</td>
<td>08-11-1994</td>
<td>NON E</td>
</tr>
<tr>
<td>EP 1284338 A2</td>
<td>19-02-2003</td>
<td>DE 60224339 T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1284338 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 4052380 B2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2003065003 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 200303 1555 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2008190114 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2011070082 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2011070097 A1</td>
</tr>
</tbody>
</table>