Abstract: For the cooling of platforms (10) of turbine blades (2) a turbine assembly has at least one opening (21, 22) for allowing cooling gas to flow from a cavity (18) under the platforms (10a, 10b) to the upper face (12) of the platforms (10a, 10b) for forming a convective cooling of the first platform (10a) and for forming a film cooling along the upper face (12) of the second platform (10b).
Published:

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Blade platform cooling in turbomachines

HELD OF THE INVENTION

[0001] The invention relates to a device and a method for cooling blade platforms in turbo- machines, in particular in gas turbines.

BACKGROUND OF THE INVENTION

[0002] Modern gas turbines operate under extreme high gas temperature conditions. This requires the use of heavy cooling of air foils and end walls of turbine blades of the turbine to ensure a sufficient lifetime of the turbine blading.

[0003] The efficiency of gas turbines can be increased by an optimizing of certain parameters of the operation of the turbine. In particular, the most relevant parameters that affect the efficiency are pressure and temperature of a fluid, which forces a rotor of the turbine to rotate. The fluid temperature normally occurring nowadays during the operation of the turbine, especially in the turbine inlet region, is already markedly above the admissible material temperatures of turbine components exposed to the fluid. As a rule, the heat dissipation of the components, which are exposed to the high temperatures, is not sufficient to avoid excess of temperature limits of said components. Material temperatures, which are too high, lead to a drop in the strength values of said heat exposed components. Temperatures exceeding said limits of the components may cause crack formation in the material of the components. Such cracks imply fatal consequences for the turbine and can result in a local or even a complete destruction of the component.

[0004] In order to avoid the problems pointed out, care has to be taken to ensure that the component temperatures do not exceed the maximum admissible material temperatures. Turbine components exposed to high temperatures are therefore cooled by a cooling medium.

[0005] A turbine blade assembly for a gas turbine engine generally includes a plurality of turbine blades mounted on a turbine disc so as to protrude radially from the disc. Each blade includes an aerofoil, which projects into a path of hot gases flowing axially through the turbine, and a circumferentially extending ring of blade platforms located at an inner base of the aerofoil of the blades. The turbine blades are closely spaced around the circumference of the rotor and the blade platforms meet to form a smooth annular surface.
Turbine blades are required to operate at high temperatures and turbine blade cooling is thus very important. It is known to cause air to flow through passages within the aerofoil of the turbine blades, before expelling the air through orifices in the aerofoil surface. The internal air flow cools the blade by convection and the expelled air also forms a cooling film over the surface of the blade. This cools the blade but does not result in a significant cooling. This technique is disclosed, for example, in document WO 2005/073516.

Due to heavy requirements regarding gas turbine emission levels, combustor chambers providing drive gas for the turbine may be convectively cooled. As a result, the gas temperature distribution in a radial direction of the gas path becomes very uniform. This leads to an increasing heat load on the blade platforms.

The internal geometry of the cooled turbine blade aerofoil is supplied by the ceramic core provided during the casting process when the blade is produced Attempts to use a similar technology for the blade platform have faced certain difficulties, among others, an unreasonable complexity of the manufacturing process which increases the price of the component.

The most spread option is to drill longitudinal holes through the blade platform ending at the platform sides to allow cooling gas to penetrate said holes, aiming at the creation of the necessary convective cooling. Another option is to allow the cooling gas to flow through holes discharging itself directly onto the platform surface to form a cooling film between the platform and the gas path. Both of these options are related to a risk of a clogging of said holes by dust and/or an exposure of the material around the holes to thermo-mechanical fatigue. The consequences of both these problems are an increased risk of blade cracking and a resulting turbine failure. Examples of platform cooling by use of channels in the platform body are provided through, e.g., documents US 2005/0058545 A1 and US 6 309 175 Bl.

It is a purpose of this invention to provide an improved solution to the above discussed drawbacks of prior art technology.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is presented a device characterized according to the enclosed claim 1.
[0012] According to a further aspect of the inventions, there is presented a turbine system according to claim 6.

[0013] According to still a further aspect of the invention, there is presented a method characterized according to the enclosed independent method claim.

[0014] Further embodiments of the invention are disclosed in the depending claims.

[0015] One advantage with the devices and method according to the invention is that the modified cooling of the blade platform is performed by means of a certain design of the sealing plate present between two adjacent platforms. This means that modifications or adjustments of the cooling film or the flow of cooling gas can easily be accomplished by a rearrangement of the design of the sealing plate. Thus it is not necessary to make any amendments of the design of the turbine blade, the platform or other components of the turbine assembly if such modifications of the cooling should be wanted. Modifications of such components would be very costly.

[0016] A further advantage is that a leakage of drive gas from the upper face of the platform into the cavity under the platform is prevented. This is due to the pressure of the cooling gas of the cavity, which pressure is such that it exceeds the pressure on the upper face of the platform, at least at a location where the openings of the sealing plate opens into an area of the upper face of the platform.

[0017] Additionally, the design according to the invention described above utilizes cooling gas from the supply upstream of said cavity. Generally the cooling gas present at the supply pointed out is in prior art devices leaking into the cavity and other spaces. Thus it is not necessary to use high pressure air dedicated to cool the blade airfoil according to well-known technology. By this, a reduction of the consumption of cooling gas is achieved. Hence, the performance of the turbine stage and the turbine unit is increased.

[0018] Besides, the described platform cooling method according to the invention provides blade shank cooling as a secondary result, as the cooling gas used is sweeping along the surfaces of the shanks forming part of the walls of said cavities. In this way a heat flux from the blade via the annular support means to the rotor of the turbine is reduced and as a consequence the temperature of the rim of a disk forming said support means and being an integral part of the rotor is thus reduced.
[0019] Still a further advantage according to the invention is that a temperature reduction from around 1000 °C to around 950 °C is achieved at the areas of the platform cooled by means of the device and method of the invention. This reduces a temperature gradient between the cooled airfoil of the blade and the previously poorly cooled platform and as a result lessens the tension between said turbine blade parts.

[0020] Still a further advantage of the invention is that an improved balance between the temperatures of the cooled airfoil and the platform is accomplished at start and stop sequences of the turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically shows a cross section through a guide vane, a rotor blade and a rim of a disk forming the support means of the rotor blade.

Fig. 2 schematically shows a projection along arrow A of fig. 1 of two adjacent rotor blades.

Fig. 3 schematically shows a cross section along the line B-B of the adjacent rotor blades of fig. 2.

Fig. 4 is a detailed view of the separating gap between two side walls of the platforms of adjacent rotor and the sealing plate arranged between said side wall according to the aspects of the invention.

Fig. 5 is a detailed view of an embodiment according to the invention of a sealing plate used as a seal between adjacent platforms.

EMBODIMENTS OF THE INVENTION

[0021] A number of embodiments of the invention and for performing the method of the invention will now be described supported by the accompanying drawings.

[0022] Referring to Fig. 1, a high pressure turbine stage of the gas turbine includes a set of stationary guide vanes 1, of which one is shown in a cross sectional side view in the left part of fig. 1. The turbine stage further includes a set of rotatable turbine blades 2, of which one is likewise shown in a cross sectional side view to the right in fig.1. The set of guide vanes 1 and the set of turbine blades are each mounted in an annular formation
with each guide vane and each turbine blade extending radially outwardly from the longitudinal axis of the turbine. Gases from a combustion process in combustors (not shown) force their way onto the guide vanes 1, whereupon the gases are expanded and imparted a "spin" in the direction of rotation of the turbine blades 2. The gases, here called the drive gas, then impact the turbine blades 2, causing rotation of a turbine rotor, on which the turbine blades are mounted. The flow direction of the drive gas is denoted by arrow F.

[0023] The turbine blades 2 are mounted on a rotatable support means in the form of a turbine disc 3, which constitutes a part of the turbine rotor. The turbine disc 3 can only be partly seen in fig. 1. The turbine blades 2 are attached to the disc 3 by means of "fir tree root" fixings. A root portion 4 of each blade 2 is generally triangular, as viewed in the longitudinal (axial) direction of the turbine, but includes serrated edges 5 (see fig. 3), which cooperate with complementary edges 6 of a recess 7 in the turbine disc 3.

[0024] Each turbine blade 2 includes an airfoil 8, which extends radially into the drive gas flowing axially through the turbine. A blade platform 10 extends circumferentially from each turbine blade 2 at a base of the airfoil 8. The platforms 10 of adjacent turbine blades 2 abut each other with a small intermediate separating gap 11 only so as to form a smooth annular surface, see figures 2, 3 and 4. Said platforms have an upper face 12 directed outwards and a lower face 13 directed inwards. Further, the platforms 10 have side walls 14, 15, which faces each other across said separating gap 11 as can best be seen in figures 3 and 4. In figure 4 a first platform 10a has a first side wall 14 and a second platform 10b, adjacent to the first platform, has a second side wall 15. Dependent upon the design of the airfoil 8, it is well-known that the upper face 12 of the first platform 10a has a pressure side (visible at the left part in fig. 4), and the upper face 12 of the second platform 10b has a suction side (visible at the right part of fig. 4).

[0025] Located between the root portion 4 and the blade platform 10 of each turbine blade 2 is a shank 16. The shanks 16 of two adjacent turbine blades 2, together with the adjacent parts of the lower faces 13 of the platforms 10 of said adjacent turbine blades, the disc 3 portion between said two shanks 16 and locking plates 17 on the upstream and downstream side, respectively, of said two shanks define a cavity 18.

[0026] The high thermal efficiency of the engine is dependent upon the gases entering the turbine stage at high temperatures. Cooling of the guide vanes 1 and the turbine blades 2 is thus very important. Continuous cooling of these components allows their environmental operating temperature to exceed the melting points of the materials from
which they are formed. Generally the cooling is performed by means of a high pressure cooling gas G, usually compressed air, but it may be composed of any mix of gases.

[0027] Between adjacent side walls 14, 15 of two adjacent platforms 10a, 10b a sealing plate 19 (see figures 3, 4 and 5) is provided to prevent a leakage of drive gas through the separating gap 11 in the direction inwards to the cavity 18. Said sealing plate 19 is according the disclosed embodiment designed to be arranged in a slot 20 at the edge of the platform 10 between a sidewall 14, 15 and the lower face 13.

[0028] An essential part of the invention is the sealing plate 19 placed in the sealing slot 20. The sealing plate 19 is, as stated, initially designed to prevent leakage from the blade inlet to the blade outlet. According to the invention, the sealing plate 19 is further used as a cooling deflector designed to control a convective and film cooling on the pressure and suction side of a platform 10. The aim of accomplishing the deflector has been arrived at be providing the sealing plate 19 with a cut-in portion 21 along an edge of sealing plate 19 (figures 4, 5). Said cut-in portion 21 opens a path for cooling gas G in a radial direction. By means of said cut-in portion 21, a room is provided between said cut-in portion 19 and the platform 10a, 10b.

[0029] The sealing plate 19 is further provided with a number of grooves 22 on the upper side of the sealing plate 19 connecting the cut-in portion 21 with the separating gap 11. By this, a continuous path is opened for cooling gas from the cavity 18 to the area above the upper faces 12 of the platforms 10a, 10b. Said continuous path consists of the cut-in portion 21, the grooves 22 and the separating gap 11. The grooves 22 are, according to the disclosed embodiment, arranged in a direction of the plane of the disc 3, preferably parallel to a tangent to said disc 3. If any control of the flow of cooling gas is wanted, the grooves can be arranged in any other preferred direction.

[0030] The number, width and cross section area of the grooves 22 are a matter of design as said design is depending on, e.g., the area to be cooled or available cooling gas - drive gas pressure difference, whereby said parameters are designed for the purpose to arrive at the wanted flow of cooling gas. Further, the location of the cut-in portion 21 along the edge of the sealing plate 19 is such that the continuous path for the cooling gas opens onto the upper face 12 of the platforms 10a, 10b towards the suction side of the platforms.

[0031] The grooves 22 are connecting said room between said cut-in portion 21 and the platform 10a, 10b with said separating gap 11 for forming a cooling gas path between
said cavity 18 and said upper face 12 of the platform 10a, 10b. The grooves 22 are in one embodiment of the invention arranged (as shown in fig. 5) orthogonal to a longitudinal direction of the cut-in portion. If an alternative control of the flow of the cooling gas is wanted, it is, of course, possible to direct to grooves otherwise, such as being inclined in a direction at least 45° off from the longitudinal direction of said cut-in portion 21.

[0032] The platform 10 cooling is arranged in the following way:
Firstly, a gas/air-gas mixture from the supply upstream of the turbine blade 2 is delivered to the cavity 18, thanks to a pressure difference between said supply and the cavity 18. An aperture 23 can be provided in the upstream locking plate 17 to improve the flow of cooling gas into the cavity 18, if necessary.
Secondly, cooling gas is flowing through the cut-in portion 21 in a radial direction. Then, as the cooling gas is directed into the grooves 22, the cooling gas is deflected into a tangential direction, sweeping close to the lower face 13 of the first platform 10a (fig. 4). In this way, the air is convectively cooling the first platform 10a at the concave side of the airfoil 8 of said first platform.
Finally, the cooling gas is flowing through the separating gap 11 between the side walls of the platforms 10a, 10b and proceeds into the grooves 22 of the sealing plate 19 and is injected uniformly from said grooves, tangentially, out onto the surface of the upper face 12 of the second platform 10b. On said second platform 10b the cooling gas, thanks to the secondary flow in the drive gas path, is streaming close to the surface of the upper face 12 at the convex side of the airfoil 8 of said second platform 10b and thus provides a film cooling of the blade platform.

[0033] The path of the flow of cooling gas implies that also the side walls 14 and 15 of the platforms are cooled by the stream of cooling gas accomplished by means of the invention (fig. 4).

[0034] It must be pointed out here that each platform of the set of annularly arranged platforms 10 serve as the denoted first platform in relation to an adjacent platform on one side and as the second platform in relation to an adjacent platform of the other side.

[0035] Additionally, the design described above allows the use of a cooling gas leakage from the supply upstream of the turbine blade 2, instead of using high pressure air dedicated for the cooling of the blade airfoils. In this way, it reduces the cooling gas consumption and consequently improves the performance of the turbine stage and an overall gas turbine performance.
[0036] Besides, the described platform cooling provides blade shank cooling by utilized cooling gas leakage. Thus, a heat flux from the turbine blade 2 to the disc 3 is reduced resulting in a reduction of the disc 3 rim temperature.

[0037] The sealing plate 19 is made from a material normally used in gas turbines. As stated previously, the design of the cut-in portion 21 and the grooves 22 can be adapted to the use and the performance wanted. An advantage with the invention is that amendments of the design of air cooling flow can easily be achieved by only changing the design of the sealing plate 19, and thus leaving the design of the turbine blade 2 unaffected.

[0038] Other embodiments of the invention may be provided. One example is the use of separate cut-in portions 21, one for each groove 22, instead of a cut-in portion 21 supplying all grooves with cooling gas.

[0039] Thus, while there have been shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto, in which claims any reference signs shall not be construed as limiting the scope of the claims.

Definitions
Throughout this document, the term "upper" relates to a direction radially outwards from the axle of rotation of the turbine rotor, whilst lower defines a direction opposite to that. "Upstream" is used as a direction opposite to the flow of gases from an inlet of the gas turbine to an outlet of the gas turbine. "Downstream" accordingly denotes a direction of said flow of gases.
The term "cut-in portion" has the same meaning as notch or recess and indicates that, as in the case of the sealing plate above, that the cross sectional area of the sealing plate is reduced along said cut-in portion. Still, in the case of said sealing plate, the cut-in portion is made along a short edge of the rectangular cross section of the sealing plate.

"between", in the case of the sealing plate being located between the first and the second side wall, does not indicate that said sealing plate in its entirety must be located between said side walls. As a matter of fact, "between" means that at least a portion of the cross section of the sealing plate is located between the first and the second platforms 10a, 10b. The cross sectional area of the sealing plate is a matter of design.
CLAIMS

1. A turbine assembly comprising:
   a blade platform (10a, 10b) having an upper face (12) and a lower face (13), a
   first (14) and a second (15) side wall,
   an airfoil (8) extending from the upper face (12),
   a separating gap (11) between the first (14) side wall of a first platform (10a) and
   the second (15) side wall of a second platform (10b),
   a sealing plate (19) arranged between said first (14) and said second (15) side
   walls for preventing a leakage of a drive gas through said separating gap (11),
   characterized in that
   said sealing plate (19) is provided with at least one opening (21, 22) for allowing
   cooling gas to flow from a cavity (18) under the platforms (10a, 10b) to the upper
   face (12) of the platforms (10a, 10b) for forming a cooling film along the upper
   face (12) of the platforms (10a, 10b).

2. The turbine assembly according to claim 1, wherein said opening (21, 22) in said
   sealing plate (19) includes at least one cut-in portion (21) along an edge of the
   sealing plate (19).

3. The turbine assembly according to claim 2, wherein said opening (21, 22) in said
   sealing plate (19) further includes at least one groove (22) connecting a space
   provided between said cut-in portion (19) and the platform (10a, 10b) with said
   separating gap (11) for forming a cooling gas path between said cavity (18) and
   said upper face (12) of the platform (10a, 10b).

4. The turbine assembly according to claim 3, wherein said groove is inclined in a
direction at least 45° off from the longitudinal direction of said cut-in portion (21).

5. The turbine assembly according to any of the preceding claims, wherein the
   opening (21, 22) opens onto a suction side of the platform (10a, 10b).

6. A turbine system including a plurality of turbine assemblies according to claim 1
   mounted on a rotatable annular support means (3), wherein
   a turbine blade (2) is provided with said platform (10a, 10b) and a shank (16)
   protruding from the lower face (13) of the platform (10a, 10b) for attaching the
   blade (2) to the annular support means (3),
a plurality of turbine blades (2) are arranged in a circumferential manner around the annular support means (3),
a cavity (18) is defined by walls including: adjacent portions of the lower faces (13) of two adjacent blade platforms (10a, 10b), turbine blade shanks (16) of said adjacent turbine blades (2), the annular support means (3) and locking plates (17) in the upstream and downstream direction respectively,
a cooling gas supply is provided upstream of said cavity (18),
characterized in that
said cooling gas is arranged to flow from said supply through an inlet into said cavity (18) and to be let out through said opening (21, 22) in said sealing plate (19) to the upper face (12) of the platforms (10a, 10b).

7. The turbine system according to claim 6, wherein, the cooling gas is compressed air or a mixture of compressed air and the drive gas.

8. Method for cooling platforms of turbine blades (2) attached side by side in an annular arrangement around a support means (3) of a rotor of a gas turbine driven by a drive gas, wherein a turbine blade (2) has a platform (10a, 10b) including an upper face (12) and a lower face (13) as well as a first (14) and a second (15) side wall, comprising the steps of:
- attaching two turbine blades (2) to said support means (3) so that the first side wall (14) of a first platform (10a) is adjacent to the second side wall (15) of a second platform (10b), said first side wall (14) and said second side wall (15) being separated by a separating gap (11),
- sealing said separating gap (11) by means of a sealing plate (19) for preventing leakage of drive gas through the separating gap (11),
- arranging an opening (21, 22) in said sealing plate (19) for letting cooling gas out in a direction from the lower faces (13) to the upper faces (12) of said platforms (10a, 10b),
- cooling adjacent platforms (10a, 10b) by means of a cooling film formed by said cooling gas flowing along the upper faces (12) of said adjacent platforms (10a, 10b) between said upper faces (12) and said drive gas.

9. The method according to claim 8, further including the step of:
- arranging said opening to include an elongated cut-in portion (21) or recess in said sealing plate (19).
10. The method according to claim 8 or claim 9, further including the step of:
   - arranging said opening to include at least one groove (22) between said cut-in
     portion (21) and said separating gap (11).
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER

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

- **INV. FOI/011/00 FOI/015/18**

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols):

- **FOID**

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, PAJ5 WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category</th>
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<td>X</td>
<td>GB 2 195 403 A (ROLLS ROYCE PLC)</td>
<td>1-10</td>
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<tr>
<td></td>
<td>7 April 1988 (1988-04-07) page 1, line 87 - page 2, line 24; figures 3-10</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>GB 2 280 935 A (ROLLS ROYCE PLC [GB])</td>
<td>1-3,5-10</td>
</tr>
<tr>
<td></td>
<td>15 February 1995 (1995-02-15) page 3, paragraph 6 - page 5, paragraph 1; figures 2-4</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>EP 1 452 694 A2 (ROLLS ROYCE PLC [GB])</td>
<td>1,3-8,10</td>
</tr>
<tr>
<td></td>
<td>1 September 2004 (2004-09-01) paragraphs [0012], [0013], [0017] - [0019], [0022], [0023]; figures 1,2,4</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>EP 1 221 539 A2 (MITSUBISHI HEAVY IND LTD [JP])</td>
<td>1-3,5-10</td>
</tr>
<tr>
<td></td>
<td>10 July 2002 (2002-07-10) paragraphs [0033], [0034]; figures 4a-c</td>
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</tr>
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Further documents are listed in the continuation of Box C

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
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Teusch, Reinhold
<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
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<tbody>
<tr>
<td>X</td>
<td>US 6 017 189 A (JUDET MAURICE [FR] ET AL) 25 January 2000 (2000-01-25) column 3, lines 47-51; figures 2,3</td>
<td>1,6-8</td>
</tr>
<tr>
<td>X</td>
<td>JP 60 022002 A (HITACHI LTD) 4 February 1985 (1985-02-04) abstract; figures 10-15</td>
<td>1</td>
</tr>
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</table>

Form PCT/ISA/210 (continuation of second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
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<tr>
<td></td>
<td></td>
<td>FR 2603967 A1</td>
<td>18-03-1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 63085203 A</td>
<td>15-04-1988</td>
</tr>
<tr>
<td>GB 2280935 A</td>
<td>15-02-1995</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>EP 1452694 A2</td>
<td>01-09-2004</td>
<td>US 2004165983 A1</td>
<td>26-08-2004</td>
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<tr>
<td></td>
<td></td>
<td>JP 2002201913 A</td>
<td>19-07-2002</td>
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<td>US 2002090296 A1</td>
<td>11-07-2002</td>
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<td></td>
<td>DE 69805669 D1</td>
<td>11-07-2002</td>
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<tr>
<td></td>
<td></td>
<td>DE 69805669 T2</td>
<td>23-01-2003</td>
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<tr>
<td></td>
<td></td>
<td>EP 0856641 A1</td>
<td>05-08-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2758855 A1</td>
<td>31-07-1998</td>
</tr>
<tr>
<td>US 4767260 A</td>
<td>30-08-1988</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>JP 60022002 A</td>
<td>04-02-1985</td>
<td>NONE</td>
<td></td>
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