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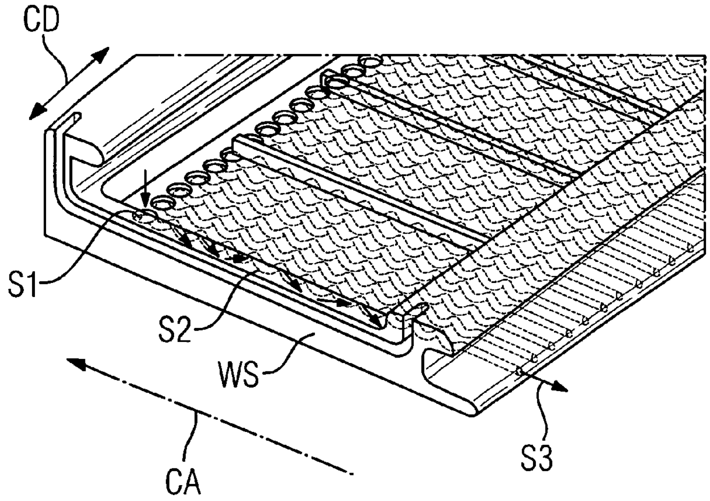
(54) Heat shield element for a gas turbine

(57) Heat shield element (HS) for a gas turbine (GT) comprising an areal wall section (WS), which extends with regard to a central axis (CA) in an axial direction and a circumferential direction (CD), said wall section (WS) being defined by limiting edges of the heat shield element (HS), said wall section (WS) is of a defined thickness (TH), said thickness depending on the axial and circumferential position extending radially from an inner surface (IS) to an outer surface (OS)
said inner surface (IS) is exposed to a hot gas path (HGP) and said outer surface (OS) is exposed to a coolant (CO) contained in a cavity (CV),
wherein the heat shield element (HS) is provided with mounting elements (ME) suitable for mounting on a supporting structure (SP). To improve cooling efficiency, cooling channels (CC) are provided through the wall of said wall section (WS) said cooling channels (CC) comprising a first section (S1) starting at the inner surface (IS), further comprising a second section (S2) extending between the inner surface (IS) and the outer surface (OS) along a length of at least three times the thickness (TH) of the wall section (WS) at that specific area of the second section and comprising a third section (S3) joining the hot gas path through the inner surface (IS) or through a limiting edge so that said cooling channels (CC) connect said cavity (CV) with the hot gas path (HGP).

FIG 3



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Description

[0001] The invention relates to a heat shield element for a gas turbine comprising an areal wall section, which extends with regard to a central axis in an axial direction and a circumferential direction, defined by limiting edges of the heat shield element, which wall section is of a defined thickness, said thickness depending on the axial and circumferential position extending radially from an inner surface to be exposed to the hot gas path to an outer surface to be exposed to a coolant, wherein the heat shield element is provided with mounting elements suitable for mounting on a supporting structure.

[0002] Further the invention relates to a gas turbine comprising a heat shield of this kind.

[0003] In order to increase the efficiency of modern gas turbines operating temperatures of gas turbines are steadily increased to improve the limiting Carnot-efficiency. The increasing operating temperatures of gas turbines lead to temperatures in the hot gas path, especially in the first stages of the expansion turbine, which exceed material properties. To enable the safe operation of these turbines our components being exposed to the hot gas must be carefully cooled by a coolant, which in most cases is air or water steam or a combination of both.

[0004] Geometrical expressions like radial, axial, circumferential and similar terms refer to a respective machine axis if not indicated otherwise.

[0005] Basically two modes of cooling have established: impingement cooling and film cooling. In most modern gas turbines a combination of both methods is applied. The hot gas path of a gas turbine is provided with heat shields conducting the hot gas along its flow path. These heat shields are very often cooled by impingement cooling, wherein a jet of coolant is applied on the radially outer surface of the heat shield wall with regard to the hot gas path. Very often these heat shields are provided with so called film cooling holes, by which a specific amount of coolant is injected into the hot gas path to establish a cooling film layered on the inner surface of the heat shield to protect the heat shield material. A heat shield element of this kind is disclosed in EP 1 507 116 A1.

[0006] The coolant, which is partly injected into the hot gas path and which is in most cases compressed and filtered ambient air, is called secondary air. The necessary amount of secondary air to enable second operation of the turbine is defined as the secondary air consumption. An increase in secondary air consumption results normally in a decrease of the turbine efficiency since this coolant not only waves the material of the hot gas component but also cooled down the hot gas resulting in less power output.

[0007] It is one object of the invention to improve the cooling of the heat shield element increasing there lifetime.

[0008] It is another object of the invention to reduce secondary air consumption resulting in a better thermal efficiency of the gas turbine.

[0009] In accordance with the invention there is provided a heat shield element of the incipiently mentioned type provided with cooling channels through the wall section comprising a first section starting at the inner surface, comprising a second section extending between the inner surface and the outer surface along a length of at least three times the thickness of the wall section at that area and comprising a third section further joining through the inner surface or joining through an edge the hot gas path.

[0010] The extension of the cooling channel along a basically parallel direction with regard to a center plane of the wall section provides a much more efficient usage of the secondary air amount with regard to cooling the heat shield, enabling a reduction of secondary air consumption by approximately 50% depending on the length and shape of the second section of the channel.

[0011] Very beneficial results can be obtained by a second section having a serpentine shape or having a helix shape.

[0012] Preferably the wall section is made of nickel based superalloy especially made of hustle alloy, which is also suitable for laser sintering. The heat shield according to the invention is preferably a hot gas component of a gas turbine, wherein the axial direction of the heat shield corresponds to a propagation of the hot gas along a main flow direction along the hot gas path. Preferably the heat shield is located in the gas turbine opposite the tip a rotating blade, where the thermal stress is intends due to the high velocity of the hot gas along this stationary heat shield.

[0013] A preferred embodiment of the invention provides a gas turbine of the forgoing describes kind, wherein the first section of the channel is axially located upstream of the third section of the channel with regard to the hot gas flow direction.

[0014] The above mentioned attributes and other features and advantages of this invention and the manner of attaining them will be come more a parent and the invention itself will be better understood by reference to the following description of the currently best note of carrying out the invention taken in conjunction with the accompanying drawings, wherein

Figure 1	shows a schematic overview including a cross section through the hot gas path showing a heat shield of the conventional type,
Figure 2	is a three dimensional depiction of a heat shield according to the invention,
Figure 3	is a hollow graphic view of a detail of the heat shield according to figure 2,
Figure 4	is a negative module showing the air in the cooling channels of figure 2 respectively figure 3,
Figure 5	is a three dimensional depiction with a circumferential section through a heat shield according to figure 2 having serpentine

shaped cooling channels.

Figure 1 shows a gas turbine GT including a schematically depiction of a gas turbine compressor GTCO compressing air A and delivering the said air A primarily to a combustor COMB. A smaller portion of the compressed air A is divided from the primary flow of the compressed air A into the combustor and supplied to a cooling air reservoir CAR as - so called - secondary air SA for cooling purpose.

[0015] The combustor COMB is supplied with fuel F to generate hot gas HG from the induced compressed air A. Said hot gas HG is supplied along a hot gas path HGP through a first stage of the gas turbine GT and subsequent further stages, which are not depicted.

[0016] The first stage consists of a plurality of first stage vanes 1STV and first stage blades 1STB downstream the first stage vanes 1STV. The first stage blades 1STB rotate along a machine axis MA of a gas turbine rotor. The radial outer tip of the first stage blades 1STB is facing radially outward a heat shield element HS. With regard to the machine axis MA a plurality of heat shield elements HS are arranged adjacent to each other in a circumferential direction CD.

[0017] The radial inner surface IS of said respective heat shield element HS defines a central axis CA concentrically. Said central axis CA might be inclined to the machine axis MA of the gas turbine GT but both axes might also be coaxial. Said radially inner surface IS of the heat shield HS is exposed to said hot gas HG of said hot gas path. A radially outer surface OS is exposed to a coolant CO - which is said secondary air SA - being supplied from a cooling air reservoir CAR through a nozzle NZ into a cavity CV, which is partly defined by the radial outer surface OS of the heat shield HS. Said cavity CV extends along the circumference and is radially defined by an axially and circumferentially extending impingement blade IP perforated by impingement holes IPH channeling secondary air jets discharging against the radial outer surface OS of the heat shield HS for cooling purpose. The discharged secondary air SA joins into the hot gas path HGP through channels at a leading ('leading'with regard to a flow direction of the hot gas HG along said hot gas path HGP) edge LE of the heat shield HS, shown in figur 3. This discharged secondary air SA establishes a cooling film CF covering the inner surface IS of the heat shield HS.

[0018] While the heat shield HS itself shown in figure 1 is of conventional type with regard to the invention the basic orientation and assembly situation according to the invention is exactly the same as shown in figure 1.

[0019] Figure 2 shows a three dimensional depiction of a heat shield element HS according to the invention. A clearly distinguishing feature compared to the heat shield HS shown in figure 1 are the coolant inlet holes CI provided on the radial outer surface OS of the heat shield HS and the coolant outlet holes CO discharging the cooling air CA into the hot gas path HGP. The coolant inlet holes CI are provided axially near a trailing edge TE (axially opposite the leading edge LE) and the cooling air outlet holes CO are provided near said leading edge LE of the heat shield HS.

[0020] For better illustration, figures 3 and 4 show the cooling channels CC in a transparent or holographic view respectively in a negative depiction showing the secondary air SA flowing through the cooling channels CC. The cooling channels CC are provided in a wall section WS of a defined wall thickness TH. The wall section WS is circumferentially and axially defined by limiting edges, for example said leading edge LE and said trailing edge TE of the heat shield element HS. In circumferential direction CD the heat shield is limited by circumferential edges CE. The cooling channels CC are provided in the wall section WS within the wall thickness TH, which extends radially from the inner surface IS to the outer surface OS.

[0021] The cooling channels CC comprise in downstream order of the secondary air SA flow a first section S1 starting at the inner surface IS, a second section extending between the inner surface IS and the outer surface OS along a lengths of at least three times the thickness TH of the wall section WS at that area and further comprises a third section S3 joining through the inner surface IS - or in this case the leading edge LE - the hot gas path HGP. In figure 4 and figure 3 the second section S2 is of a helix shape.

[0022] In figure 5 said second section S2 is of a serpentine shape.

Claims

1. Heat shield element (HS) for a gas turbine (GT) comprising an areal wall section (WS), which extends with regard to a central axis (CA) in an axial direction and a circumferential direction (CD), said wall section (WS) being defined by limiting edges of the heat shield element (HS), said wall section (WS) is of a defined thickness (TH), said thickness depending on the axial and circumferential position extending radially from an inner surface (IS) to an outer surface (OS) said inner surface (IS) is exposed to a hot gas path (HGP) and said outer surface (OS) is exposed to a coolant (CO) contained in a cavity (CV),
wherein the heat shield element (HS) is provided with mounting elements (ME) suitable for mounting on a supporting structure (SP),
characterized in that
cooling channels (CC) are provided through the wall of said wall section (WS) said cooling channels (CC) comprising a first section (S1) starting at the inner surface (IS), further comprising a second section (S2) extending between the inner surface (IS) and the outer surface (OS) along a length of at least three times the thickness (TH) of the wall section (WS) at that specific area of the second section and compris-

ing a third section (S3) joining the hot gas path through the inner surface (IS) or through a limiting edge so that said cooling channels (CC) connect said cavity (CV) with the hot gas path (HGP).

2. Heat shield element (HS) according to claim 1, wherein the second section (S2) is of a serpentine shape.

3. Heat shield element (HS) according to claim 1, wherein the second section (S2) is of a helix shape.

4. Heat shield element (HS) according to one of the previous claims,
wherein the wall section is made of a nickel based super alloy, preferably containing between:

0,2 - 3 wt-%	Co
1 - 30 wt-%	Cr
5,5 - 28,5 wt-%	Mo
0 - 4 wt-%	W
1,5 -15 wt-%	Fe
0,08 - 1 wt-%	Si
0 - 3 wt-%	Mn
0,01 - 0,12 wt-%	C

and balance Ni.

5. Heat shield element (HS) according to at least one of the previous claims,
wherein the wall section (WS) is produced by laser sintering.

6. Gas turbine (GT) comprising at least one heat shield element (HS) according to at least one of the previous claims 1, 2, 5.

7. Gas turbine (GT) according to claim 6,
wherein the axial direction corresponds to a propagation of a hot gas (HG) along a main flow direction along a hot gas path (HGP).

8. Gas turbine (GT) according to claim 7,
wherein the first section (S1) is axially located upstream of the third section (S3) with regard to the hot gas (HG) flow direction.

FIG 1

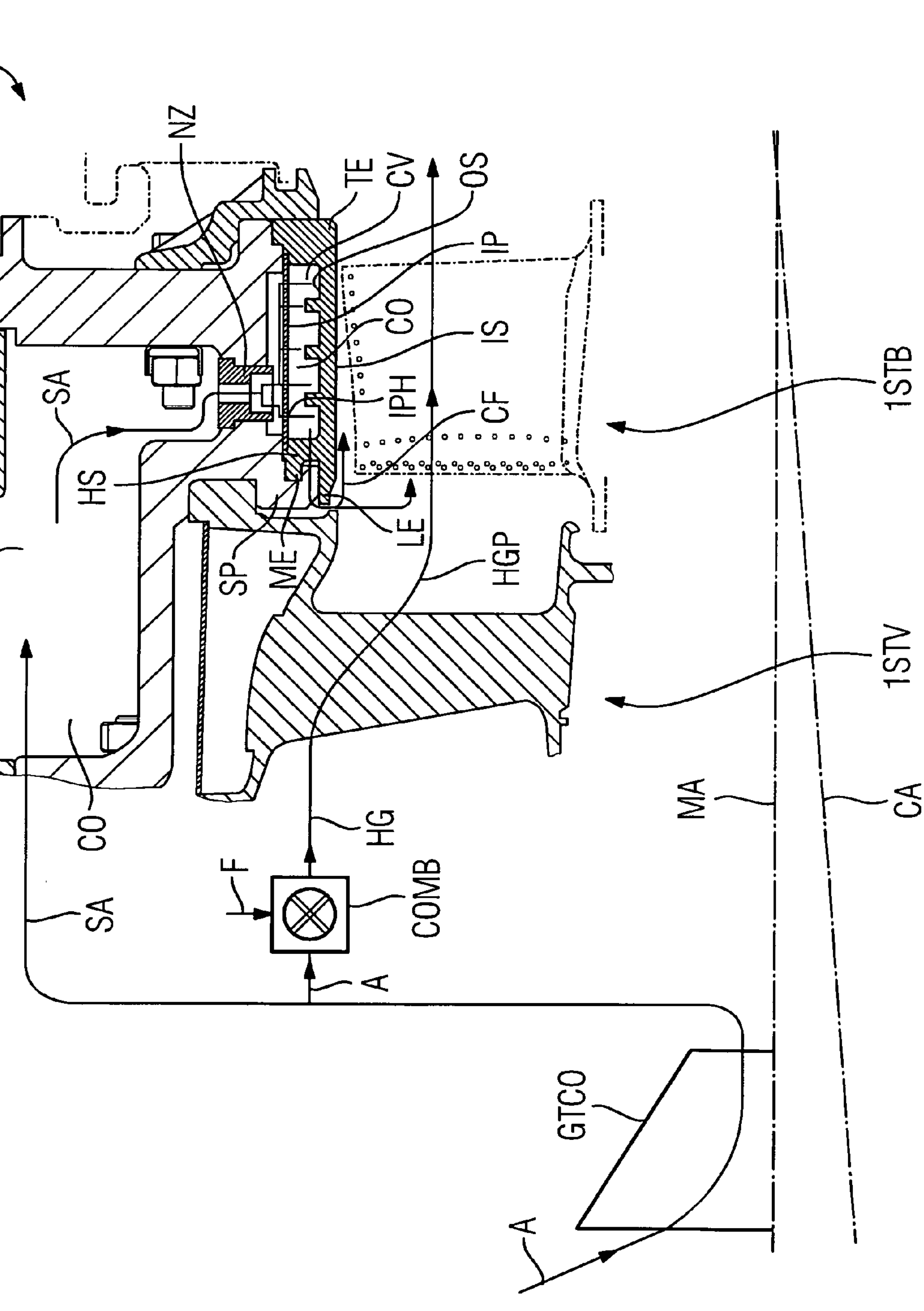
GT
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FIG 2

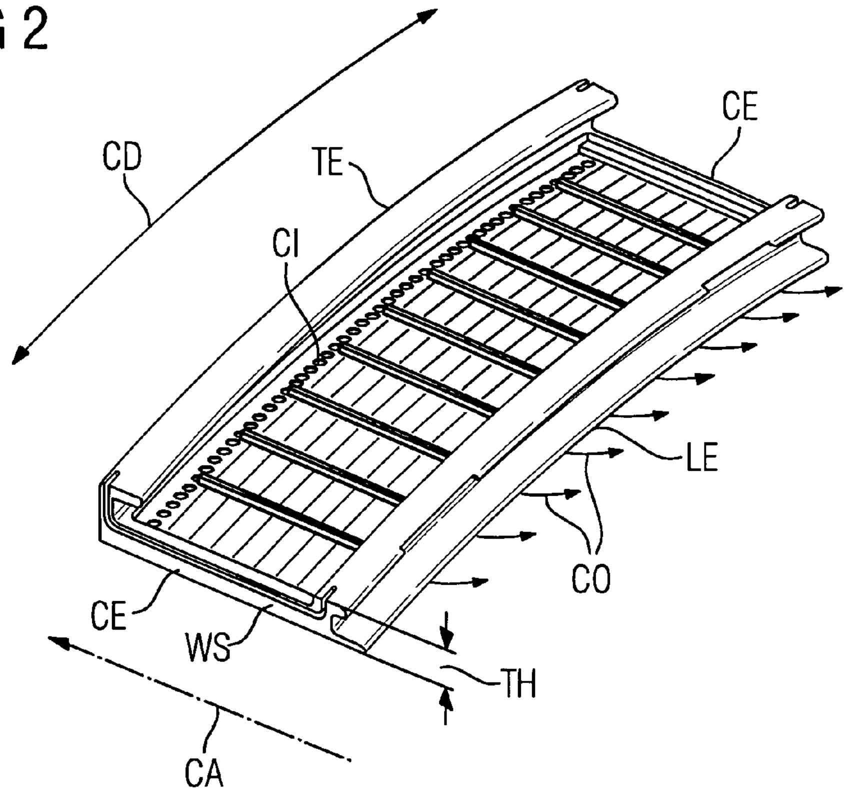


FIG 3

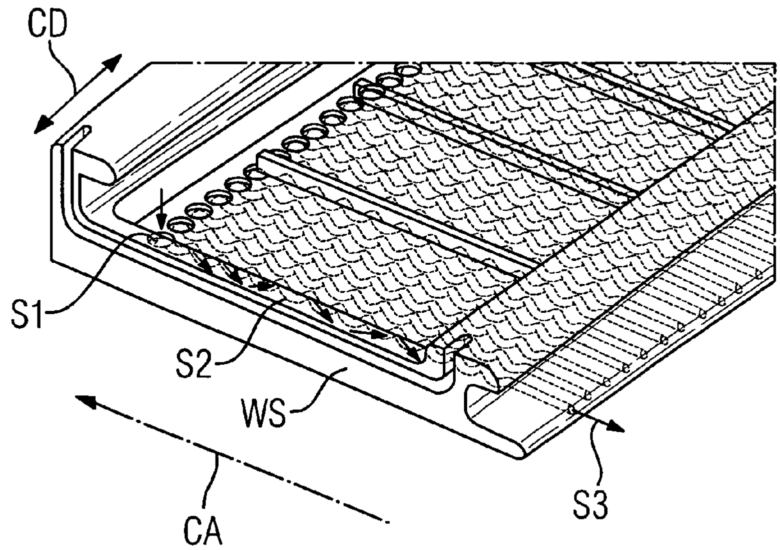


FIG 4

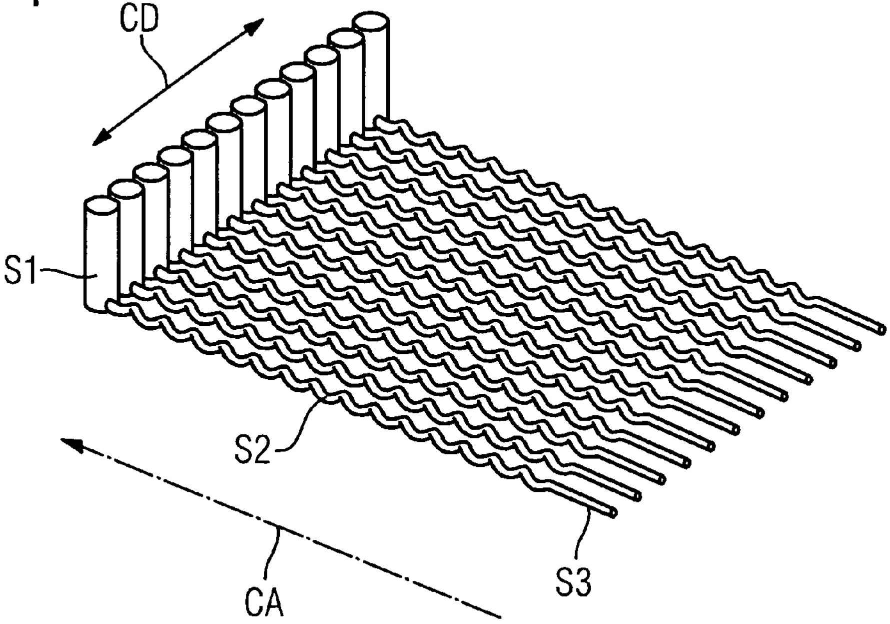
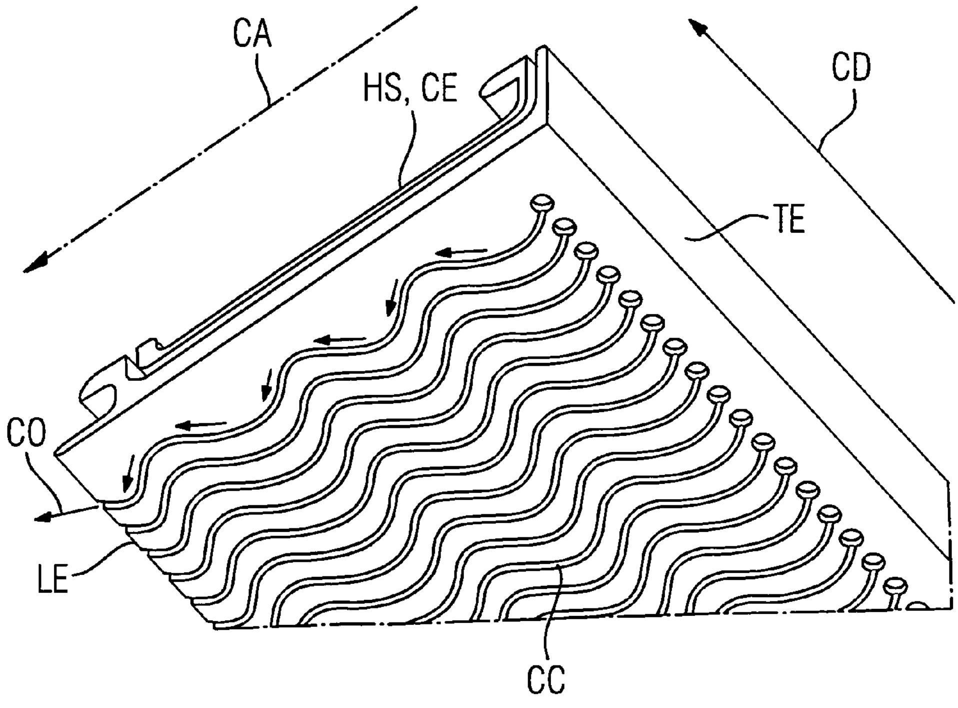


FIG 5



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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 4851

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	2 December 2011	Souris, Christophe

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A : technological background
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	2 December 2011	Souris, Christophe

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