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(71) Applicant: **Siemens Aktiengesellschaft**
80333 München (DE)

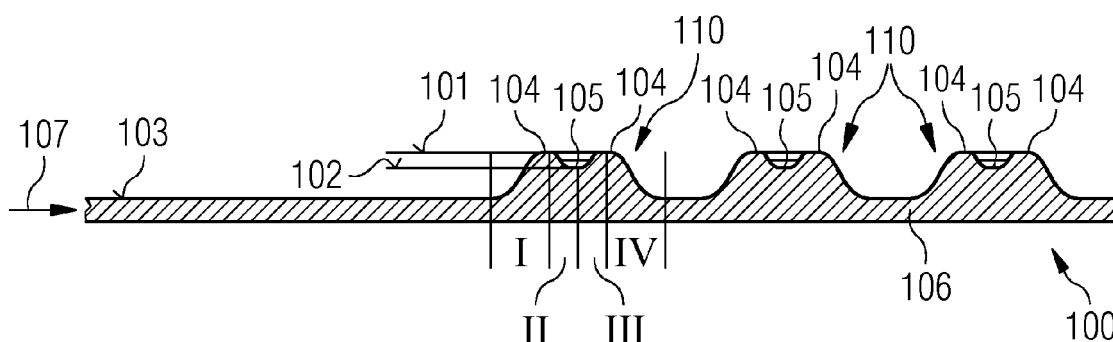
(72) Inventor: **Headland, Paul**
Lincoln, LN1 1NA (GB)

(54) **An enhanced cooling surface**

(57) The invention relates to a wall element (100) for a gas turbine. The wall element (100) comprises a surface running along a surface plane (103) of the wall element (100). The surface comprises a profile (110) extending from the surface plane (103), wherein the profile (110) has a cross section within a cross section plane (106) which is perpendicular to the surface plane (103). The profile (110) comprises along a direction (107) being orientated parallel to the surface plane (103) a first section (I) which runs from the surface plane (103) to a first elevation plane (101) which is parallel to the surface plane (103) and which is spaced from the surface plane (103), a second section (II) which runs from the first elevation plane (101) to a second elevation plane (102) which is parallel to the surface plane (103) and which is located between the first elevation plane (101) and the surface plane (103), a third section (III) which runs from the second elevation plane (102) to the first elevation plane (101) and a fourth section (IV) which runs from the first elevation plane (101) to the surface plane (103).

variation plane (101) which is parallel to the surface plane (103) and which is spaced from the surface plane (103), a second section (II) which runs from the first elevation plane (101) to a second elevation plane (102) which is parallel to the surface plane (103) and which is located between the first elevation plane (101) and the surface plane (103), a third section (III) which runs from the second elevation plane (102) to the first elevation plane (101) and a fourth section (IV) which runs from the first elevation plane (101) to the surface plane (103).

FIG 1



Description

Field of invention

[0001] The present invention relates to a wall element for a gas turbine. Furthermore, the invention relates to a method for manufacturing the wall element.

Art Background

[0002] Various parts in industrial and aero gas turbines, are exposed to hot gas streams. Hence, in particular the wall sections facing the hot gas stream have to be cooled in order to increase the lifetime of the wall sections.

[0003] In order to cool the wall sections, cooling air streams are directed to the surfaces of the cooling wall sections. The surfaces of the wall section may comprise profiles with a variety of different shapes in order to increase the surface area of the surface for improving a heat transfer between the cooling gas and the wall section.

[0004] In order to increase the surface area of the surface, the size of the profiles may be increased. In particular, the profile extends from the surface of the wall section in the direction to the cooling gas stream. The extending length in the direction to the cooling gas stream is limited because the profile causes a disproportional increase in pressure drop in proportion to the cooling effectiveness by the cooling gas stream.

[0005] US 7,743,821 B2 describes a heat exchanger which includes a tube having axially spaced fins or a continuously spirally wound fin about the tube. One or more of the fins are dimpled, mechanically or molded, to provide concavities and projections on opposite sides of the fins or alternating concavities and projections on an opposite side of the fins.

[0006] US 7,013,962 B2 describes a fluid cooler assembly which comprises a vertically stacked first type and second different type of tubular panel subassembly construction integrated with a third subassembly of external corrugated fin construction positioned above and below each tubular panel subassembly. Furthermore, the fluid cooler assembly comprises bell shaped manifold end areas.

Summary of the Invention

[0007] It is an objective of the present invention to improve the cooling efficiency of a gas turbine.

[0008] This objective is solved by a wall element, by a gas turbine and by a method for manufacturing the wall element according to the independent claims.

[0009] According to a first aspect of the present invention, a wall element for a gas turbine is presented. The wall element comprises a surface running along a surface plane of the wall element. The surface comprises a profile extending from the surface plane, wherein the profile has

a cross section within a cross section plane which is substantially perpendicular to the surface plane. The profile comprises along a direction being orientated parallel to the surface plane and orientated within the cross section plane a first section which runs from the surface plane to a first elevation plane which is parallel to the surface plane and which is spaced from the surface plane, a second section which runs from the first elevation plane to a second elevation plane which is parallel to the surface plane and which is located between the first elevation plane and the surface plane, a third section which runs from the second elevation plane to the first elevation plane and a fourth section which runs from the first elevation plane to the surface plane.

[0010] According to a further aspect of the present invention, a turbine comprising the above mentioned wall element is presented.

[0011] According to a further aspect of the present invention, a method for manufacturing the wall element is presented. The wall element comprises a surface running along a surface plane of the wall element, wherein the surface comprises a profile extending from the surface plane. The profile has a cross section within a cross section plane which is perpendicular to the surface plane.

The method comprises the forming along a direction being orientated parallel to the surface plane and within the cross section plane of a first section of the profile, which runs from the surface plane to a first elevation plane which is parallel to the surface plane and which is spaced from the surface plane, of a second section of the profile, which runs from the first elevation plane to a second elevation plane which is parallel to the surface plane and which is located between the first elevation plane and the surface plane, of a third section of the profile, which runs from the second elevation plane to the first elevation plane, and a fourth section of the profile, which runs from the first elevation plane to the surface plane.

[0012] The wall element of a turbine describes a part of a housing of a gas turbine component. For example, the wall element may be a part of the combustor wall or a part of the turbine nozzle wall. In general, the wall element may describe a housing of a gas turbine component which is exposed to hot gas or steam. The wall element may be attached to the gas turbine in such a way that one side of the wall element is exposed to a cooling fluid passing the wall element and an opposed side of the wall element may be exposed to a hot working fluid of the gas turbine, such as hot gas, hot exhaust gas or steam.

[0013] The surface running along the surface plane of the wall element may describe the side of the wall which is exposed to the hot working fluid or which is exposed to the cooling fluid streaming through the cooling channel. In particular, the wall element may form a part of the cooling channel. The surface of the wall section may comprise a curved or a plane shape. In particular, the surface may form an annular shape around a centre line e.g. around a turbine shaft of the turbine.

[0014] The above described profile describes a three-dimensional profile which extends from the surface. The profile may form an asymmetrical profile or may be rotationally symmetric. The first, second, third and fourth sections are located one after another along the direction. Each section describes a predefined run (of the contour) of the profile within the cross section plane. The three-dimensional profile may be formed by rotating the cross section plane around a symmetry axis being e.g. parallel to a normal of the surface plane. The three-dimensional profile is formed by rotating the cross section plane 360° degree around the symmetry axis, for example.

[0015] The first section and the fourth section (i.e. the contour of the first section and the contour of the fourth section) run between the surface plane and the first elevation plane. The second and the third section (i.e. the contour of the second section and the contour of the third section) run between the first elevation plane and the second elevation plane.

[0016] The first elevation plane and the second elevation plane are parallel to the surface plane in the region where the profile is formed at the surface. The first elevation plane and the second elevation plane may be defined spaced apart from the surface plane of the wall element. The second elevation plane is defined between the first elevation plane and the surface plane. In particular, the second elevation plane is spaced apart from the first elevation plane.

[0017] In an exemplary embodiment, the first elevation plane and the second elevation plane are defined and located in the environment of the body of the wall element, such that the first section and the fourth section are formed by an attached protrusion (e.g. a pimple) onto the surface of the wall element and the second section and the third section form a dimple. Alternatively, the first elevation plane and the second elevation plane may be located below the surface plane, i.e. within the body of the wall element. Hence, the first section and the fourth section form a groove or a dimple in the body of the wall section and the second section and the third section form a protrusion.

[0018] Moreover, a plurality of the above described profiles may be formed onto or within the wall element. Each of the profile may comprise the same shape or may comprise a different shape between each other.

[0019] By the present invention, the surface area of a profile onto the surface is increased without increasing the height of the profile. In particular, the first elevation plane is spaced from the surface plane. In conventional approaches, in order to increase the surface of the profile, the distance between the first elevation plane and the surface plane is increased in order to increase the surface area. By the approach of the present invention, an intermediate second elevation plane is defined between the first elevation plane and the surface plane. The profile comprises a predefined run between the first elevation plane and the second elevation plane.

[0020] In particular, metaphorically speaking a waved

run of the profile between the first section and the fourth section may be formed, wherein the profile comprises a cross section with a contour which comprises two local maxima (where the contour reaches the first elevation plane) and three local minimum (e.g. a first local minimum, where the contour reaches the second elevation plane and further a second and third local minimum, where the contour reaches the surface plane). Hence, the surface area is increased without increasing the distance between the first elevation plane and the surface plane, i.e. the height of the profile.

[0021] By increasing the surface area of the profile, the heat transfer is improved, such that the wall element may be cooled more efficiently. The way how to improve the effectiveness of the cooling air is to give the profile formed for example by a dimple or a protrusion on the surface an extra (additional) surface area between the first section and the fourth section. This extra surface area is formed by the second section and the third section e.g. by forming a further protrusion or a further dimple within the profile formed by the first section and the fourth section.

[0022] Summarizing, by forming the profiles as described above to a surface of a wall element, the cooling air efficiency is improved, the hot metal temperatures are reduced, the total cooling air requirements are reduced and the engine efficiency may be improved.

[0023] According to a further exemplary embodiment, the first section and the fourth section are formed with a first curved shape. In particular, the first section and the fourth section may have a curved shape within the cross section plane, such as a parabolic run. Moreover, the first and the fourth section may comprise an S-shaped run within the cross section plane. By having a curved shape, the manufacturing is simplified and the local stress concentrations reduced. Additionally or alternatively, the run of the profile in the first section and/or the fourth section may comprise a linear run.

[0024] According to a further exemplary embodiment, the second and the third section are formed with a second curved shape. Additionally or alternatively, the run of the profile in the second section and/or the third section may comprise a linear run.

[0025] According to a further exemplary embodiment, the first section and the fourth section in combination form a protrusion, wherein the second section and the third section form a dimple.

[0026] Hence, the first section and the fourth section define a first sub-profile defining the larger, outer shape of the profile. The second and the third section define an inner, smaller second sub-profile, which is located within the (edges of the) first sub-profile. In particular, the extension direction with respect to the surface plane of the first sub-profile defined by the first and fourth section is opposed with respect to the extending direction of the second sub-profile defined by the second and third section.

[0027] According to another exemplary embodiment,

the first section and the fourth section in combination form a dimple (e.g. also called cavity) and wherein the second section and the third section in combination form a protrusion (e.g. also called projection).

[0028] According to a further exemplary embodiment, the first section and the fourth section in combination form within the cross section plane a triangular, trapezoidal or a parabolic shaped profile between the surface plane and the first elevation plane. The second section and the third section in combination form within the cross section plane a triangular, trapezoidal or a parabolic shaped dimple. In other words, the first section and the fourth section in combination form along the cross section plane a protrusion, wherein the second and third section in combination form along the cross section plane a cut out (dimple) in the center are of the protrusion formed between the first and fourth section.

[0029] According to a further exemplary embodiment, the profile further comprises along the direction a fifth section and a sixth section, wherein the fifth section and the sixth section are located along the direction between the second section and the third section, wherein the fifth section runs from the second extension plane to a third extension plane which is parallel to the surface plane. The sixth section runs from the third extension plane to the second extension plane. By the present exemplary embodiment it is indicated, that between the second section and the third section a plurality of further sections may be interposed along the direction so that a plurality of different shapes of the profile between the first elevation plane and the surface plane may be formed, so that the overall surface area of the profile and hence of the wall element may be increased.

[0030] It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to apparatus type claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the apparatus type claims and features of the method type claims is considered as to be disclosed with this application.

Brief Description of the Drawings

[0031] The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The invention will be described in more detail hereinafter with reference to examples of embodiment but to which the invention is not limited.

Fig. 1 shows a cross-sectional view of the cross section plane of the wall element according to an exemplary embodiment of the present invention;

Fig. 2 shows a perspective view of profiles of the wall element, wherein the first and fourth sections form protrusions and the second and third sections form dimples according to an exemplary embodiment of the present invention;

Fig. 3 shows a cross-sectional view of the perspective view of the wall element shown in Fig. 2 according to an exemplary embodiment of the present invention;

Fig. 4 shows a perspective view of profiles of the wall element, wherein the first and fourth sections form dimples and the second and third sections form protrusions according to an exemplary embodiment of the present invention; and

Fig. 5 shows a cross-sectional view of the perspective view of the wall element shown in Fig. 4 according to an exemplary embodiment of the present invention.

Detailed Description

[0032] The illustrations in the drawings are schematic. It is noted that in different figures, similar or identical elements are provided with the same reference signs.

[0033] Fig. 1 shows a wall element 100 of a gas turbine. The wall element 100 comprises a surface running along a surface plane 103 of the wall element 100. The surface comprises a profile 110 extending from the surface plane 103. The profile 110 has a cross-section within a cross section plane 106 which is perpendicular to the surface plane 103. The profile 110 comprises along a direction 107 being orientated parallel to the surface plane 103 a first section I which runs from the surface plane 103 to a first elevation plane 101 which is parallel to the surface plane 103 and which is spaced from the surface plane 103. Furthermore, the profile 110 comprises along the direction 107 a second section II which runs from the first elevation plane 101 to a second elevation plane 102 which is parallel to the surface plane 103 and which is located between the first elevation plane 101 and the surface plane 103. Furthermore, the profile 110 comprises along the direction 107 a third section III which runs from the second elevation plane 102 to the first elevation plane 101. Furthermore, the profile 110 comprises along the direction 107 a fourth section IV which runs from the first elevation plane 101 to the surface plane 103.

[0034] The above described run of the profile along the direction 107 may be taken from the view of the cross section plane 106 from Fig. 1. In the exemplary embodiment shown in Fig. 1, the profile 110 forms a protrusion between the first section I and the fourth section IV along

the direction 107. Between the first section I and the fourth section IV the second section II and the third section III form a dimple. Hence, by forming the dimple in the second section II and third section III, the overall surface area of the profile 110 is increased. In particular, the dimple is formed between a high point (local maximum) 104 of the first section I at the first elevation plane 101 and a further high point (further local maximum) 104 of the fourth section IV at the first elevation plane 101, wherein the dimple has a low point (local minimum) 105 at the second elevation plane 102.

[0035] The high points 104 may define the point or the points on the first section I and the fourth section IV which comprises the largest distance (i.e. in direction of the normal of the surface plane 103) to the surface plane 103. The high points 104 define a local maximum of the profile 110, at which the algebraic sign of the first derivation of the contour of the profile 110, in particular the tangent, changes. The high points 104 are located onto the first elevation plane 101 which defines the largest distance to the surface plane 103. Between the first elevation plane 101 and the surface plane 103, the second elevation plane 102 is located. The run of the profile along the direction 107 between the second section II and the third section III is defined between the second elevation plane 102 and the first elevation plane 101. As can be taken from Fig. 1, the second section II is defined between the high point 104 of the first section I and the low point 105, which is a point on the second elevation plane 102. The third section III is defined between the low point 105 and the high point 104 of the fourth section IV.

[0036] As shown in Fig. 1, the profile 110 forms along the direction 107 within the cross section plane a parabolic run in the first section I and the fourth section IV. Furthermore, as shown in Fig. 1, the profile forms along the direction 107 a protrusion layout between the first section I and the fourth section IV. The second section II and the third section III are located between the first section I and the fourth section IV and form a dimple (cut-out) in the cup shaped protrusion.

[0037] Fig. 2 shows a pattern of profiles 110 formed along the surface plane 103 of the wall element 100. Each profile 110 forms between the first section I and the fourth section IV a protrusion, wherein at a cone section of the protrusion a dimple is formed, wherein the dimple is defined between the second section II and the third section III as shown more detailed in Fig. 1.

[0038] Fig. 3 shows a cross-section of the profiles shown in Fig. 2. As can be taken from Fig. 3, the sections I to IV are arranged along the direction 107 one after another. Within the cross section plane 106 the profile 110 forms two high points 104 on the first elevation plane 101 (shown in Fig. 1) and one low point 105 located on the second elevation plane 102 which is located between the first elevation plane 101 and the surface plane 103.

[0039] Fig. 4 shows a wall section 100 with a pattern of profiles 110, wherein each profile 110 forms between the first section I and the fourth section IV a dimple. At a

core section, which is defined by the second section II and the third section III, the profile 110 comprises a protrusion for increasing the surface area.

[0040] Fig. 5 shows a cross-sectional view of the embodiment shown in Fig. 4. As can be taken from Fig. 5, each profile 110 comprises along its cross section plane 106 a dimple between the first section I and the fourth section IV, wherein between the first section I and the fourth section IV, the second section II and the third section III are located which form a protrusion in the core area of the dimple shape of the profiles 110 for increasing the surface area of each profile 100.

[0041] According to the embodiments each single protrusion or dimple of the profiles 110 may be rotational symmetric. In other embodiments it may also be advantageous if the protrusion or dimple may not be rotational symmetric, e.g. if formed as a cube or a block.

[0042] The invention may be applied to any turbine nozzle component, i.e. a surface washed by a hot gas. Besides wall elements or heat shields, also platforms of blades or vanes could be considered. The profiles 110 may be located on laminar surfaces that are anyhow present to guide the hot gases.

[0043] It should be noted that the term "comprising" does not exclude other elements or steps and "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

Claims

1. Wall element (100) for a gas turbine, the wall element (100) comprising

a surface running along a surface plane (103) of the wall element (100),
wherein the surface comprises a profile (110) extending from the surface plane (103),
wherein the profile (110) has a cross section within a cross section plane (106) which is perpendicular to the surface plane (103),
wherein the profile (110) comprises along a direction (107) being orientated parallel to the surface plane (103)

a) a first section (I) which runs from the surface plane (103) to a first elevation plane (101) which is parallel to the surface plane (103) and which is spaced from the surface plane (103),

b) a second section (II) which runs from the first elevation plane (101) to a second elevation plane (102) which is parallel to the surface plane (103) and which is located between the first elevation plane (101) and the

- surface plane (103),
 c) a third section (III) which runs from the second elevation plane (102) to the first elevation plane (101), and
 d) a fourth section (IV) which runs from the first elevation plane (101) to the surface plane (103).
2. Wall element (100) according to claim 1, wherein the first section (I) and the fourth section (IV) are formed with a first curved shape. 10
 3. Wall element (100) according to claim 1 or 2, wherein the second section (II) and the third section (III) are formed with a second curved shape. 15
 4. Wall element (100) according to one of the claims 1 to 3, wherein the first section (I) and the fourth section (IV) form a protrusion, and wherein the second section (II) and the third section (III) form a dimple. 20
 5. Wall element (100) according to one of the claims 1 to 4, wherein the first section (I) and the fourth section (IV) in combination form a dimple, and wherein the second section (II) and the third section (III) in combination form a protrusion. 25
 6. Wall element (100) according to one of the claim 1 to 5, wherein the first section (I) and the fourth section (IV) in combination form within the cross section plane a triangular, trapezoidal or a parabolic shaped profile between the surface plane (103) and the first elevation plane (101), and wherein the second section (II) and the third section (III) in combination form within the cross section plane a triangular, trapezoidal or a parabolic shaped dimple. 30 35 40
 7. Wall element (100) according to one of the claim 1 to 6, wherein the profile (110) further comprises along the direction (107) 45
 - e) a fifth section, and
 - f) a sixth section, 50
 wherein the fifth section and the sixth section are located between the second section (II) and the third section (III), wherein the fifth section runs from the second elevation plane (102) to a third elevation plane which is parallel to the surface plane (103), and wherein the sixth section runs from the third elevation plane to the second elevation plane (102). 55
 8. Turbine comprising a wall element (100) as set forth in one of the claims 1 to 7.
 9. Method of manufacturing a wall element (100) for a gas turbine, wherein the wall element (100) comprises a surface running along a surface plane (103) of the wall element (100), wherein the surface comprises a profile (110) extending from the surface plane (103), wherein the profile (110) has a cross section within a cross section plane (106) which is perpendicular to the surface plane (103), wherein the method comprises forming along a direction (107) being orientated parallel to the surface plane (103)
 - a) a first section (I) of the profile (110), which runs from the surface plane (103) to a first elevation plane (101) which is parallel to the surface plane (103) and which is spaced from the surface plane (103),
 - b) a second section (II) of the profile (110), which runs from the first elevation plane (101) to a second elevation plane (102) which is parallel to the surface plane (103) and which is located between the first elevation plane (101) and the surface plane (103),
 - c) a third section (III) of the profile (110), which runs from the second elevation plane (102) to the first elevation plane (101), and
 - d) a fourth section (IV) of the profile (110), which runs from the first elevation plane (101) to the surface plane (103).

FIG 1

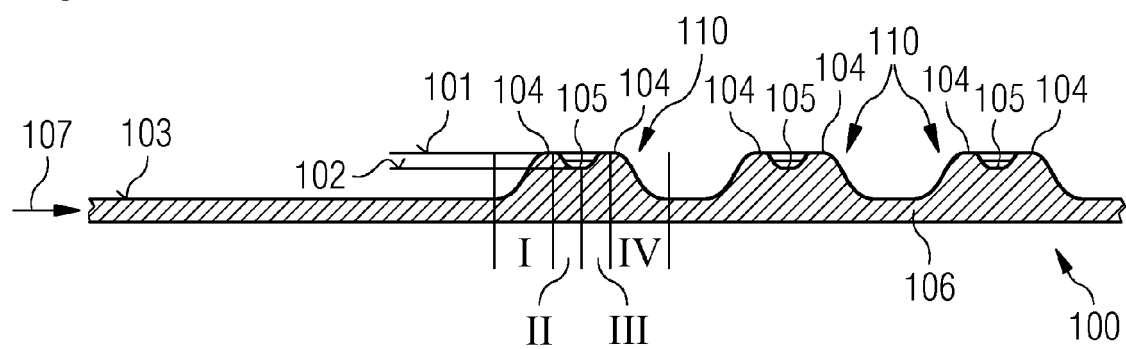


FIG 2

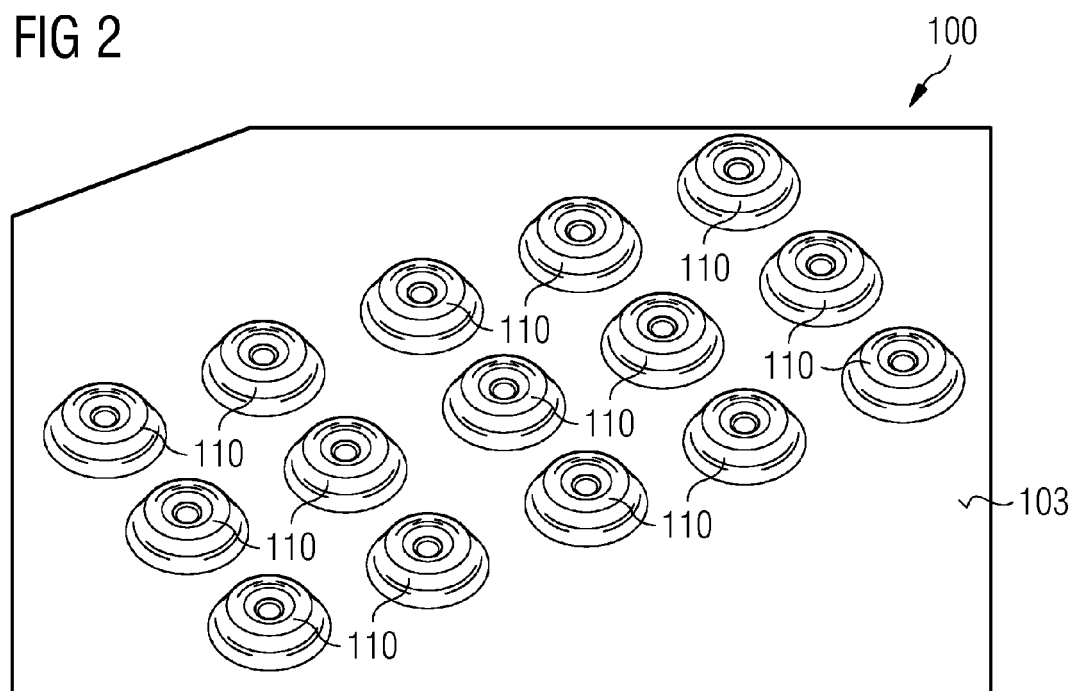


FIG 3

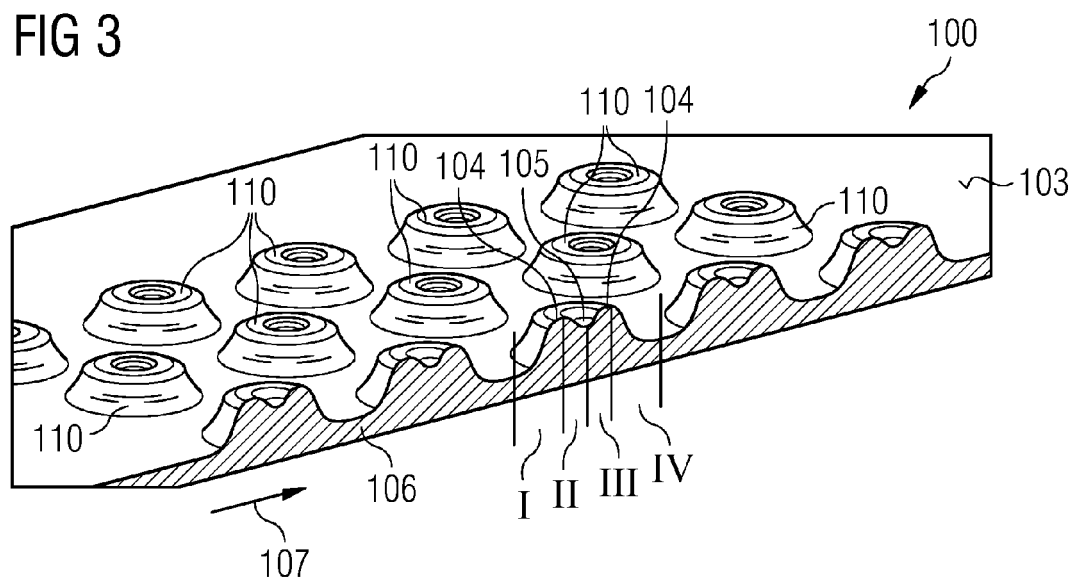


FIG 4

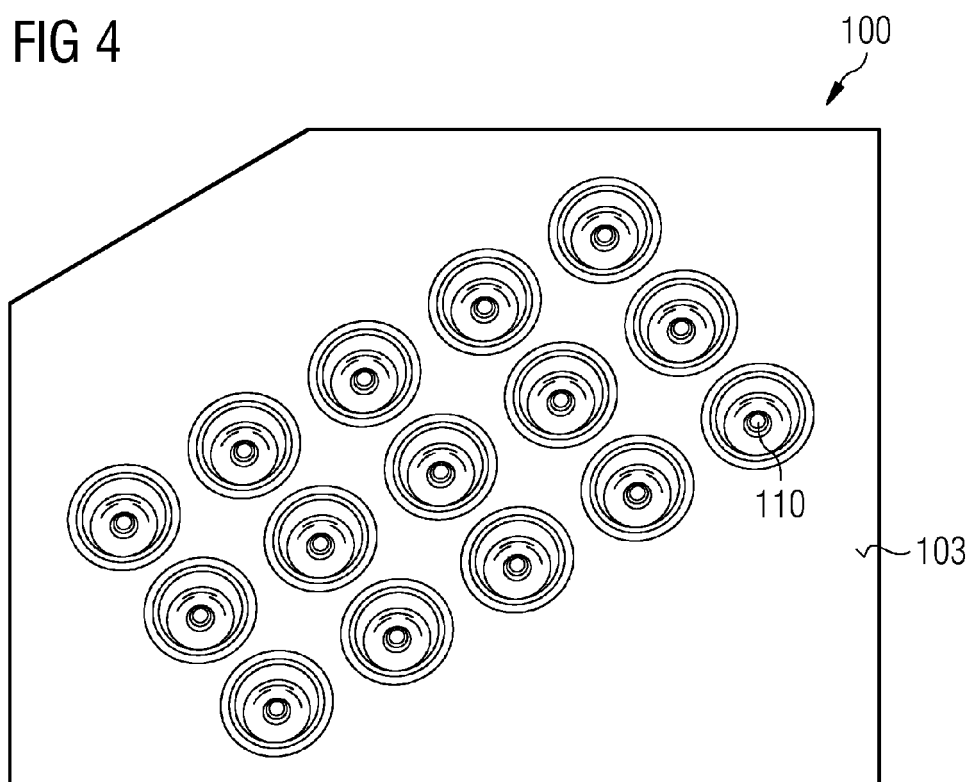
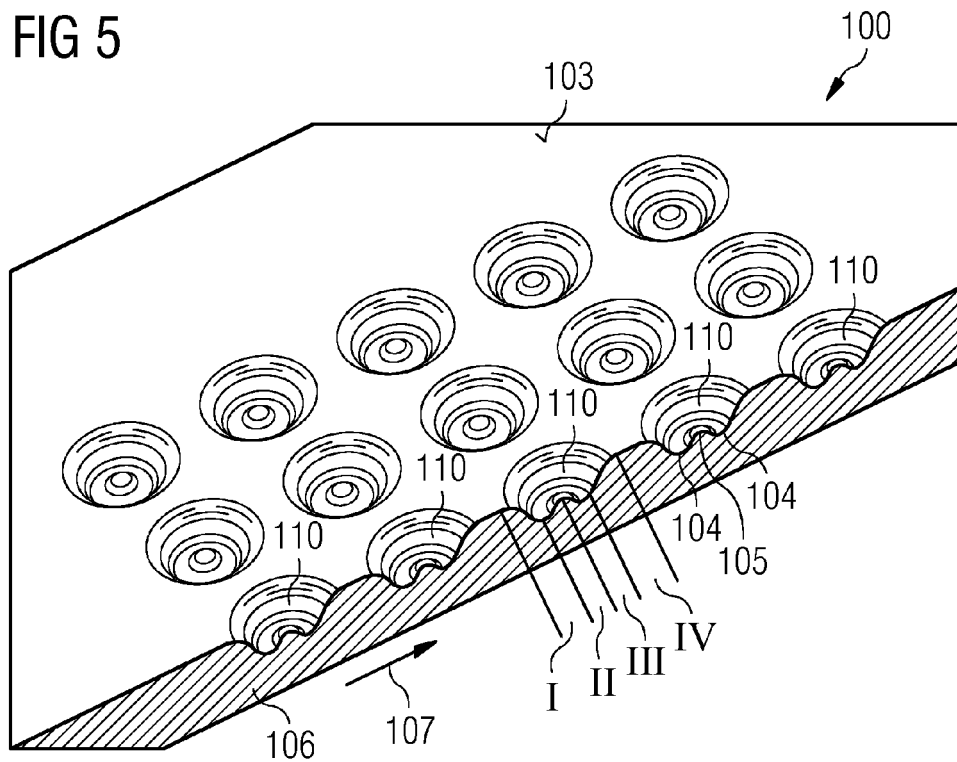


FIG 5





EUROPEAN SEARCH REPORT

Application Number
EP 11 16 4140

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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			
Place of search The Hague		Date of completion of the search 3 November 2011	Examiner Oliveira, Casimiro
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 16 4140

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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