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(54) **Stator heat shield segment**

(57) The invention relates to a stator heat shield segment (10) for a gas turbine, comprising: an outside plate (20) facing a hot gas path of the gas turbine; an inside plate (30) facing away from the outside plate and exposed to cooling air; at least one serpentine cooling channel (100) disposed between the outside plate and the inside plate, the serpentine cooling channel comprises straight portions (104, 110, 112) extending parallelly with each other, bent portions (106, 108) connecting adjacent strait portions respectively, an inlet riser portion (102) for introducing coolant disposed perpendicularly to the serpentine cooling channel at one end of the serpentine channel; and an outlet portion (114) disposed at an opposite end of the serpentine channel.

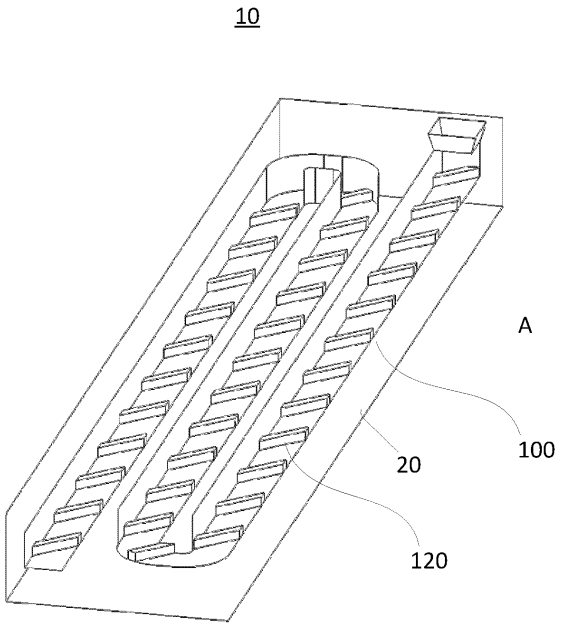

Fig. 4

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Description

Technical Field

[0001] The present invention relates to cooling for gas turbine, in particular, to a stator heat shield segment for a gas turbine.

Background of the Invention

[0002] In the installed state, stator heat shields are situated on a stator and/or on a housing of a gas turbine. They are usually mounted on a guide vane carrier and form a radial border for a hot gas path of the gas turbine in the area of the rotor blades of a rotor of the gas turbine. As a rule, a plurality of such stator heat shields is arranged adjacent to one another in the circumferential direction with regard to an axis of rotation of the rotor, thereby forming a closed ring of individual stator heat shields. The individual stator heat shields here form ring segments. The stator heat shields protect the housing and/or the guide vane carriers from exposure to the hot gas of the gas turbine. The outside of the stator heat shields is exposed to the hot gas, while the inside of the respective stator heat shield facing away from the hot gas path is exposed to a suitable cooling air to cool the respective stator heat shield. Due to this cooling, the lifetime of the stator heat shields can be increased. Fundamentally, however, there is a need for increasing the lifetime of such stator heat shields further. Cooling of a stator heat shield(SHS), particularly of first stage is a very challenge task. Cooling effectiveness is limited to convective cooling scheme, since film cooling of hot gas exposed surface is not applicable at area where the rotating blade passes the SHS. This is for two reasons. Firstly, the complex flow field in the gap between SHS and blade tip does not allow for cooling film development and resulted film effectiveness is very low and extremely hard to predict and measure. Secondly, in case of rubbing events cooling hold openings are often closed by this event, thus preventing required cooling air outflow that would have detrimental effect on the whole cooling system and significantly reduce lifetime.

[0003] A component of a gas turbine engine is provided in US20120251295 A1. The component includes an external wall which, in use, is exposed on one surface thereof to working gas flowing through the engine. The component further includes effusion cooling holes formed in the external wall. In use, cooling air blows through the cooling holes to form a cooling film on the surface of the external wall exposed to the working gas. The component further includes an air inlet arrangement which receives the cooling air for distribution to the cooling holes. The component further includes a plurality of metering feeds and a plurality of supply plena. The metering feeds meter the cooling air from the air inlet arrangement to respective of the supply plena, which in turn supply the metered cooling air to respective portions of the cooling holes.

[0004] A shroud section for a gas turbine engine is proposed in US6139257 A. To cool the shroud assembly in the high pressure turbine section of a gas turbine engine, high pressure cooling air is directed in metered flow to baffle plenums and thence through baffle perforations to impingement cool the rails and back surfaces of the shroud. Impingement cooling air then flows through elongated, convection cooling passages in the shroud sections and exits to flow along the shroud front surface with the main gas stream to provide film cooling. The aft rail of the shroud sections is provided with one or more cooling holes to impingement cool the annular retaining ring or C-clip retaining the shroud sections on the shroud hangers. This cooling air then travels aftward on the inboard side of the C-clip to provide convection cooling of the C-clip. In an alternative embodiment, cooling air is directed at the aft corners of the shroud base to avoid overheating.

[0005] A turbine shroud is proposed in US20050058534 A1. A turbine wall includes a metal substrate having front and back surfaces. A thermal barrier coating is bonded atop the front surface. A network of flow channels is laminated between the substrate and the coating for carrying an air coolant therebetween for cooling the thermal barrier coating. In this turbine shroud, cooling channels are separated from hot gas by thin layers of TBC and bondcoat only that strains very high level of failure risk in case of rubbing event.

[0006] Heat shield element (HS) for a gas turbine (GT) is proposed in EP2549063A1, which comprises 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).

Summary of the Invention

[0007] It is an object of the present invention is to pro-

vide a stator heat shield segment which may save coolant with substantial cooling effectiveness.

[0008] This object is obtained by A stator heat shield segment for a gas turbine, comprising: an outside plate facing a hot gas path of the gas turbine; an inside plate facing away from the outside plate and exposed to cooling air; at least one serpentine cooling channel disposed between the outside plate and the inside plate, the serpentine cooling channel comprises straight portions extending parallelly with each other, bent portions connecting adjacent strait portions respectively, an inlet riser portion for introducing coolant disposed perpendicularly to the serpentine cooling channel at one end of the serpentine channel; and an outlet portion disposed at an opposite end of the serpentine channel.

[0009] According to one example embodiment of the present invention, a cross section of at least a part of the straight portions is adjustable by means of additive manufacturing method.

[0010] According to one example embodiment of the present invention, the additive manufacturing method is selective laser melting.

[0011] According to one example embodiment of the present invention, a shape of the cross section of the serpentine channel is selected from the group consisting of square, rectangular, hexagon, trapezoid and triangle.

[0012] According to one example embodiment of the present invention, grooves are disposed on a surface of the inside plate opposite to the serpentine channel in a manner that the grooves are located between the straight portions.

[0013] According to one example embodiment of the present invention, a flow barrier element is disposed inside the serpentine channel.

[0014] According to one example embodiment of the present invention, the flow barrier element is selected from the group consisting of plain ribs, V shaped ribs, W shaped ribs, pins, vortex generators and dimples.

[0015] According to one example embodiment of the present invention, a plurality of serpentine channels are arranged in the stator heat shield segment in a manner that the plurality of serpentine channels are parallel to each other.

Brief Description of the Drawings

[0016] The objects, advantages and other features of the present invention will become more apparent upon reading of the following non-restrictive description of preferred embodiments thereof, given for the purpose of exemplification only, with reference to the accompany drawing, through which similar reference numerals may be used to refer to similar elements, and in which:

Fig. 1 shows a perspective view of a stator heat shield (SHS) segment according to one example embodiment of the present invention;

Fig. 2a-2e show part of the cross section of the SHS segment according to one example embodiment of the present invention;

Fig.3 shows a plan view of another SHS segment according to another example embodiment of the present invention;

Fig. 4 shows another perspective view of the SHS segment according to another example embodiment of the present invention; and

Fig.5a-5f show alternative structures for the flow barrier element.

Detailed Description of Different Embodiments of the Invention

[0017] Fig. 1 shows a perspective view of a stator heat shield (SHS) segment 10 according to one example embodiment of the present invention, where part of the SHS segment 10 is removed to expose the structure inside. As shown in Fig. 1, the SHS segment 10 comprises a an outside plate 20 facing a hot gas path of the gas turbine; an inside plate 30(as shown in Fig.2) facing away from the outside plate 20 and exposed to cooling air; a serpentine cooling channel 100 disposed between the outside plate 20 and the inside plate 30. The serpentine cooling channel 100 comprises straight portions 104, 110 and 112 extending parallelly with each other; bent portions 106 and 108 connecting adjacent strait portions 104 and 110, and 110 and 112, respectively; a inlet riser portion 102 for introducing coolant disposed perpendicularly to the serpentine cooling channel 100 at one end of the serpentine channel 100; and an outlet portion 114 disposed at an opposite end of the serpentine channel 100. It should be noticed that, as shown in Fig.1, the inlet riser portion 102 may be structured to be a funnel shape in order to facilitate introduction of coolant, such as cooling air. Even though not shown in Fig. 1, it should also be noticed that the outlet portion 114 may be configured to angle to the straight portion 112 in order to facilitate arrangement of the serpentine channel 100 in the SHS segment 10 as shown in Fig. 3.

[0018] Fig. 2a-2e show part of the cross section of the SHS segment 10 according to one example embodiment of the present invention. As shown in Fig.2a, the serpentine channel 100 may be configured to be a tube shape, such as a sealed tube, with certain cross section shape such as square. Fig.2b-2e show different cross section shape for the serpentine channels according to example embodiments of the present invention, where the cross section shape of the serpentine channel 100 may be configured to be trapezoid, rectangle, hexagon. According to another example embodiment of the present invention, as shown in Fig. 2d-2e, grooves 40 may be disposed on a surface of the inside plate opposite to the serpentine

channel 100 in a manner that the grooves 40 are located between the straight portions and extended along the straight portions 104, 110 and 112. The grooves 40 improve the ratio of cold to hot metal volume which in turn is beneficial for cyclic life time of the SHS segment 10.

[0019] Fig.3 shows a plan view of another SHS segment 10 according to another example embodiment of the present invention. As shown Fig.3, a plurality of serpentine channels 100 may be arranged in the SHS segment 10 in a manner that the plurality of serpentine channels 100 are parallel to each other. In practice, the cross section of at least a part of the straight portions 104, 110 and 112 may be adjusted by means of additive manufacturing method, such as selective laser melting to optimize heat transfer rates and mechanical stiffness and subsequently provide more uniform metal temperature which subsequently reduce thermal gradient. As shown, the straight portions of adjacent serpentine channels are narrowed to form a substantial oval shape. It should be understood by those skilled in the art that, various change can be made to the cross section of the straight portions of the serpentine channels in order to achieve desired hot gas boundary conditions.

[0020] Fig. 4 shows another perspective view of the SHS segment 10 according to another example embodiment of the present invention. As shown in Fig.4, a flow barrier element 120 such as plain rib is disposed inside the serpentine channel 100 in order to enhance heat transfer rates. The plain rib is angled to a wall of the serpentine channel 100 as shown in Fig.4.

[0021] Fig.5a-5f show alternative structures for the flow barrier element 120, where the flow barrier element 120 may be configured to be V shaped ribs, W shaped ribs, pins, vortex generators and dimples as shown by Fig 5a to 5f respectively. Fig. 5a shows the flow barrier element is configured to be V shaped ribs, Fig. 5b shows the flow barrier element is configured to be W shaped ribs, Fig. 5c shows the flow barrier element is configured to be pins, which are disposed in middle of the serpentine channel and/or attached to the wall of the serpentine channel, Fig. 5d shows the flow barrier element is configured to be vortex generators, which are disposed in middle of the serpentine channel and/or attached to the wall of the serpentine channel, Fig. 5e shows the flow barrier element is configured to be dimples, which are disposed in middle of the serpentine channel and/or attached to the wall of the serpentine channel. These flow barrier elements are provided to increase the cooling effectiveness and ensure maximum heat utilization with minimum coolant consumption.

[0022] With present invention, it can achieve significant coolant saving with substantial cooling effectiveness.

[0023] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

List of Reference Numerals

[0024]

10	stator heat shield segment
20	outside plate
30	inside plate
102	inlet riser portion
104	straight portion
106	bent portion
108	bent portion
110	straight portion
112	straight portion
114	outlet portion
120	flow barrier element

Claims

1. A stator heat shield segment for a gas turbine, comprising:

an outside plate facing a hot gas path of the gas turbine;
an inside plate facing away from the outside plate and exposed to cooling air;
at least one serpentine cooling channel disposed between the outside plate and the inside plate, **characterized in that**,
the serpentine cooling channel comprises
straight portions extending parallelly with each other,
bent portions connecting adjacent strait portions respectively,
an inlet riser portion for introducing coolant disposed perpendicularly to the serpentine cooling channel at one end of the serpentine channel; and

an outlet portion disposed at an opposite end of the serpentine channel.

2. The stator heat shield segment according to claim 1, **characterized in that**, a cross section of at least a part of the straight portions is adjustable by means of additive manufacturing method.

3. The stator heat shield segment according to claim 2, **characterized in that**, the additive manufacturing method is selective laser melting.

4. The stator heat shield segment according to any of claim 1 to 3, **characterized in that**, a shape of the cross section of the serpentine channel is selected from the group consisting of square, rectangular, hexagon, trapezoid and triangle.

5. The stator heat shield segment according to any of claim 1 to 4, **characterized in that**, grooves are disposed on a surface of the inside plate opposite to the serpentine channel in a manner that the grooves are located between the straight portions.

6. The stator heat shield segment according to any of claim 1 to 5, **characterized in that**, a flow barrier element is disposed inside the serpentine channel.

7. The stator heat shield segment according to any of claim 1 to 6, **characterized in that**, the flow barrier element is selected from the group consisting of plain ribs, V shaped ribs, W shaped ribs, pins, vortex generators and dimples.

8. The stator heat shield segment according to any of claim 1 to 7, **characterized in that**, a plurality of serpentine channels are arranged in the stator heat shield segment in a manner that the plurality of serpentine channels are parallel to each other.

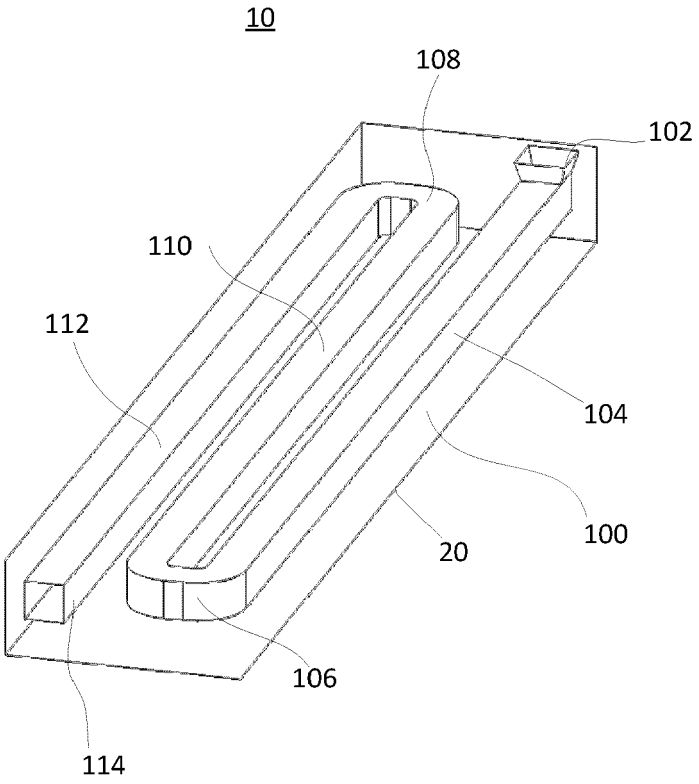

Fig. 1

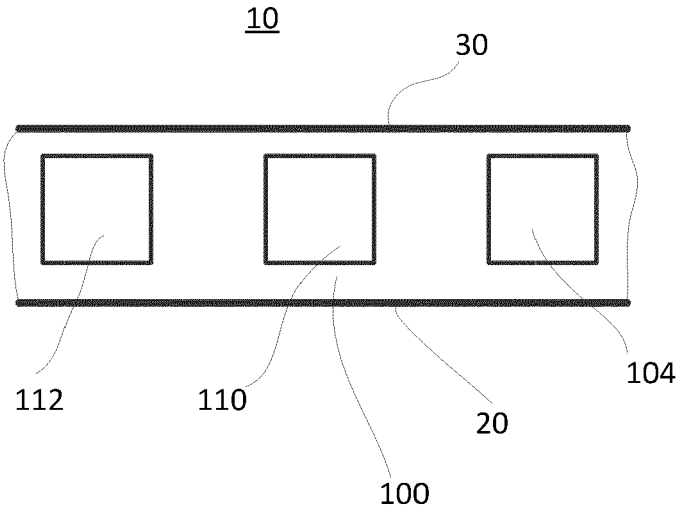

Fig. 2a

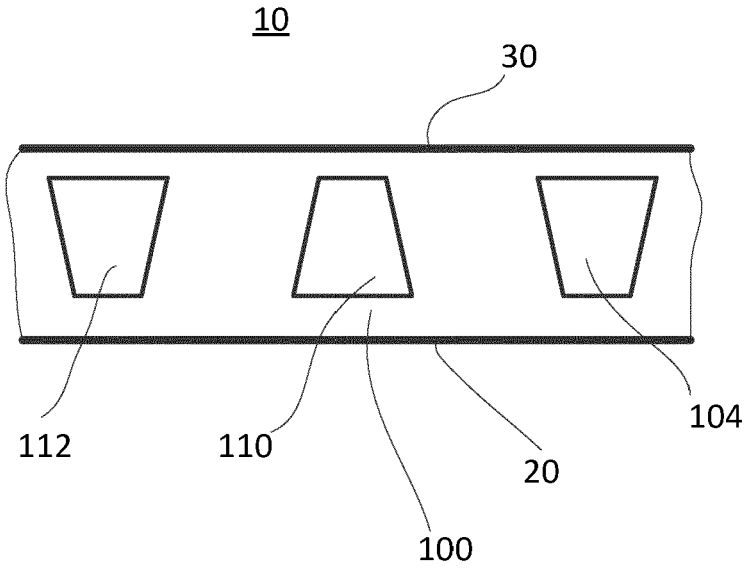

Fig. 2b

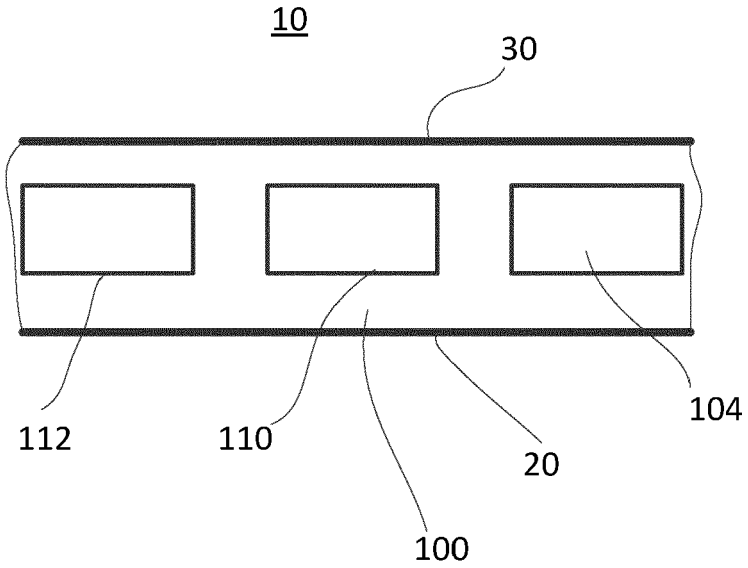

Fig. 2c

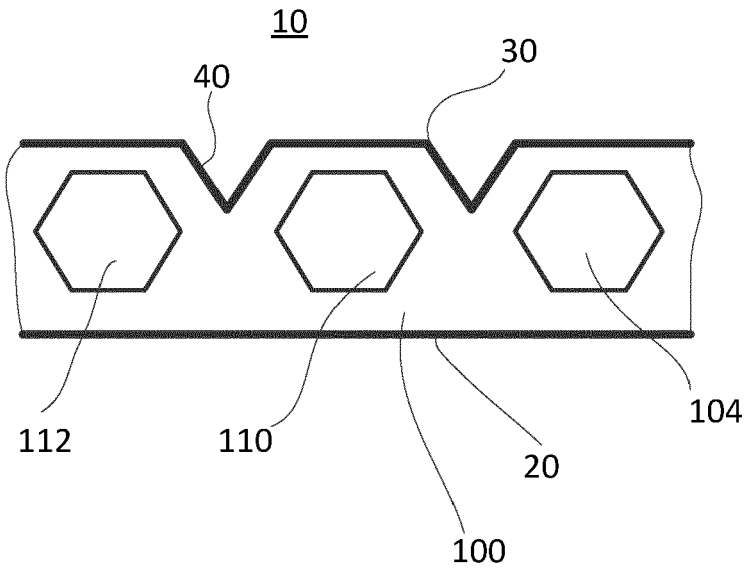

Fig. 2d

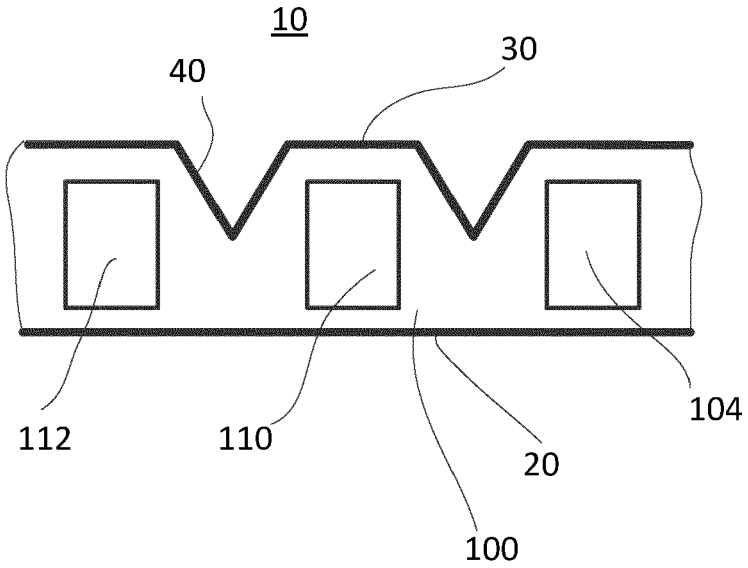

Fig. 2e

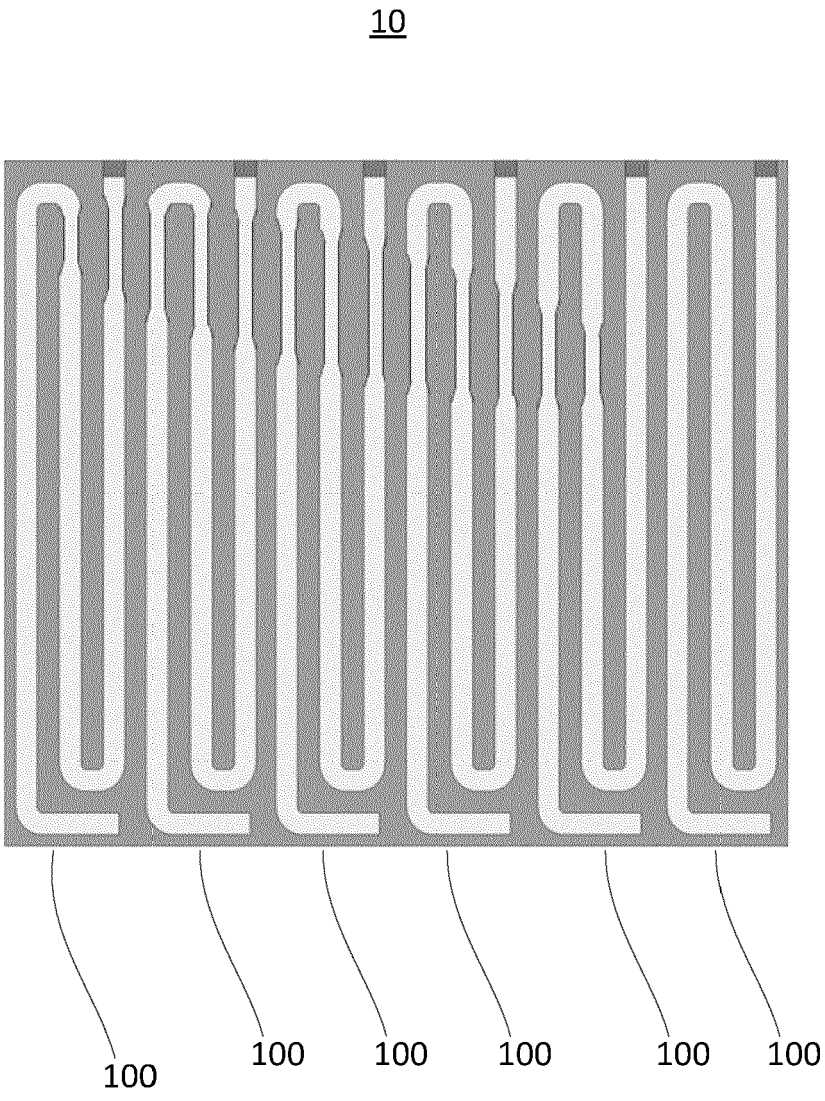

Fig. 3

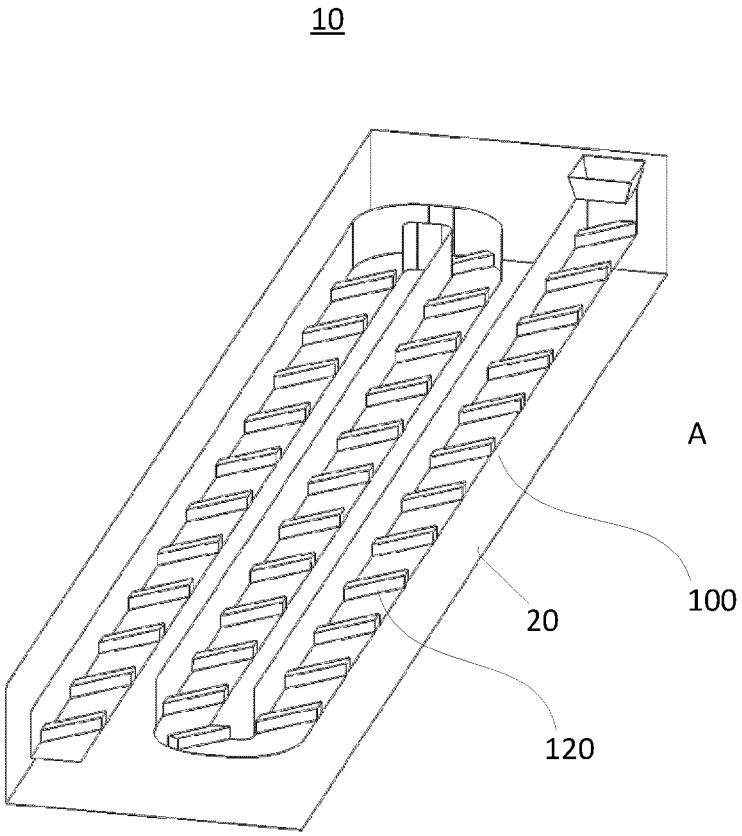

Fig. 4

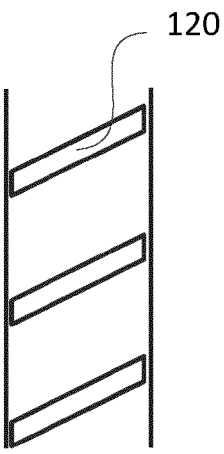

Fig. 5a

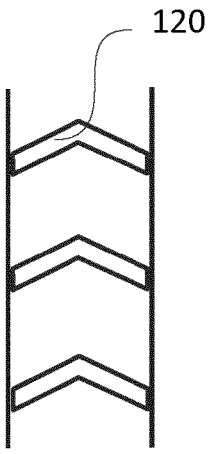

Fig. 5b

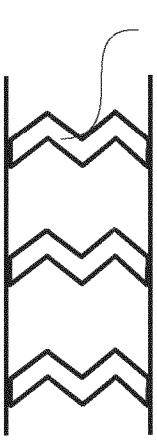

Fig. 5c

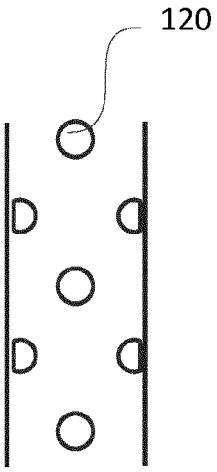

Fig. 5d

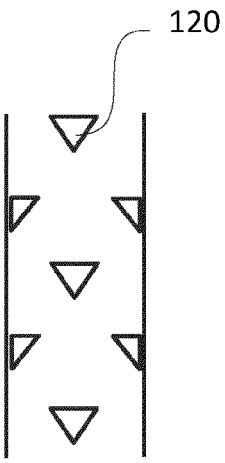

Fig. 5e

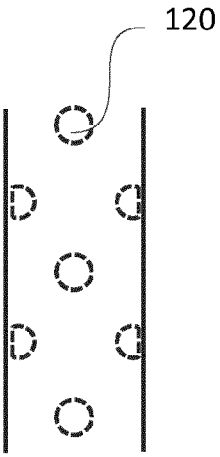

Fig. 5f

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EUROPEAN SEARCH REPORT

Application Number
EP 14 15 1020

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2007/041827 A1 (CAMUS STEPHANE [FR]) 22 February 2007 (2007-02-22) * figures 2,4,6 *	1-8	INV. F01D11/24
X	US 8 449 246 B1 (LIANG GEORGE [US]) 28 May 2013 (2013-05-28) * column 2, line 48 - line 58; figures 1,2,4 *	1-5,8	
X	US 2010/183428 A1 (LIANG GEORGE [US]) 22 July 2010 (2010-07-22) * figures 2,4 *	1-8	
X	US 2008/127652 A1 (PUTZ HEINRICH [DE]) 5 June 2008 (2008-06-05) * figure 6 *	1-5,8	
X	EP 1 063 388 A2 (UNITED TECHNOLOGIES CORP [US]) 27 December 2000 (2000-12-27) * paragraph [0028]; figures 2-5 *	1-5,8	
X,D	US 2005/058534 A1 (LEE CHING-PANG [US] ET AL) 17 March 2005 (2005-03-17) * figures 5-8 *	1-5,8	TECHNICAL FIELDS SEARCHED (IPC) F01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 March 2014	Rolé, Florian

CATEGORY OF CITED DOCUMENTS

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10-03-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007041827 A1	22-02-2007	CA 2531519 A1	27-01-2005
		EP 1644615 A1	12-04-2006
		FR 2857406 A1	14-01-2005
		JP 4536723 B2	01-09-2010
		JP 2007516375 A	21-06-2007
		RU 2348817 C2	10-03-2009
		US 2007041827 A1	22-02-2007
		WO 2005008033 A1	27-01-2005
US 8449246 B1	28-05-2013	NONE	
US 2010183428 A1	22-07-2010	NONE	
US 2008127652 A1	05-06-2008	EP 1672281 A1	21-06-2006
		EP 1836442 A1	26-09-2007
		US 2008127652 A1	05-06-2008
		WO 2006064038 A1	22-06-2006
EP 1063388 A2	27-12-2000	DE 60025074 T2	29-06-2006
		DE 60031185 T2	23-08-2007
		EP 1063388 A2	27-12-2000
		EP 1602800 A1	07-12-2005
		EP 1607575 A1	21-12-2005
		JP 2001020703 A	23-01-2001
		US 6247896 B1	19-06-2001
US 2005058534 A1	17-03-2005	CA 2480983 A1	17-03-2005
		EP 1517008 A2	23-03-2005
		JP 2005090512 A	07-04-2005
		US 2005058534 A1	17-03-2005

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20120251295 A1 **[0003]**
- US 6139257 A **[0004]**
- US 20050058534 A1 **[0005]**
- EP 2549063 A1 **[0006]**