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(54) **METHOD FOR MANUFACTURING A COOLING PLATE FOR A METALLURGICAL FURNACE**

VERFAHREN ZUR HERSTELLUNG EINER KÜHLUNGSPLATTE FÜR EINEN METALLURGISCHEN OFEN

PROCÉDÉ DE FABRICATION D UNE PLAQUE DE REFROIDISSEMENT POUR FOUR MÉTALLURGIQUE

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Description

Technical field

[0001] The present invention generally relates to a method for manufacturing a cooling plate for a metallurgical furnace.

Background Art

[0002] Such cooling plates for a metallurgical furnace, also called staves, are well known in the art. They are used to cover the inner wall of the outer shell of the metallurgical furnace, as e.g. a blast furnace or electric arc furnace, to provide: (1) a heat evacuating protection screen between the interior of the furnace and the outer furnace shell; and (2) an anchoring means for a refractory brick lining, a refractory guniting or a process generated accretion layer inside the furnace. Originally, the cooling plates have been cast iron plates with cooling pipes cast therein. As an alternative to cast iron staves, copper staves have been developed. Nowadays, most cooling plates for a metallurgical furnace are made of copper, a copper alloy or, more recently, of steel.

[0003] Different production methods have been proposed for copper stave coolers. Initially, an attempt was made to produce copper staves by casting in moulds, the internal coolant channels being formed by a sand core in the casting mould. However, this method has not proved to be effective in practice, because the cast copper plate bodies often have cavities and porosities, which have an extremely negative effect on the life of the plate bodies. The mould sand is difficult to remove from the channels and the channels are often not properly formed.

[0004] A cooling plate made from a forged or rolled copper slab is known from DE 2 907 511 C2. The coolant channels are blind boreholes introduced by deep drilling the rolled copper slab. The blind boreholes are sealed off by welding in plugs. Then, connecting bores are drilled from the rear side of the plate body into the blind boreholes. Thereafter, connection pipe-ends for the coolant feed or coolant return are inserted into these connecting bores and welded to the stave body. With these cooling plates, the above-mentioned disadvantages related to casting are avoided. In particular, cavities and porosities in the plate body are virtually precluded. The above manufacturing method is however relatively expensive both in labour and material. Furthermore, due to considerable mechanical and thermal stress to which the stave cooler is exposed, the different welded connection joints are critical as regards fluid tightness. In addition, since the channels are integral with the stave body, there is only one level of separation between the coolant and the furnace interior, i.e. if the stave body cracks open, coolant will leak. A leakage of coolant fluid into the furnace however leads to a significant risk of explosion and should therefore be avoided at all cost.

Technical problem

[0005] It is an object of the present invention to provide an improved method for manufacturing a cooling plate for a metallurgical furnace, wherein the method does not display the aforementioned drawbacks. This object is achieved by a method as claimed in claim 1.

General Description of the Invention

[0006] A method for manufacturing a cooling plate for a metallurgical furnace in accordance with the present invention comprises the steps of providing a slab of metallic material, the slab having a front face, an opposite rear face and four side edges; and providing the slab with at least one cooling channel by drilling at least one blind borehole into the slab, wherein the blind borehole is drilled from a first edge towards an opposite second edge. In accordance with an important aspect of the present invention, the method comprises the further steps of deforming the slab in such a way that a first edge region of the slab is at least partially bent towards the rear face of the slab; and machining excess material from the front and rear faces of the slab to produce a cooling plate having a panel-like body wherein an opening to the cooling channel is located in the rear face.

[0007] By bending the slab towards the rear face and subsequently machining excess material from the front and rear faces of the slab, the opening to the cooling channel is located in the rear face. Compared to the prior art method, as e.g. described in DE 2 907 511 C2, it is no longer necessary to seal off the opening to the cooling channel in the first edge by welding in a plug. Nor is it necessary to drill a connecting bore between the rear face and the cooling channel to access the cooling channel in the first edge region. The removal of these process steps reduces both labour and material costs.

[0008] More importantly, however, the absence of the plug provides a more reliant cooling plate. Indeed, as the cooling plate is exposed to considerable mechanical and thermal stress, in particular in the edge regions of the cooling plate, the plug has to be considered as a weak point. If the weld of the plug deteriorates, fluid tightness of the cooling channel can no longer be guaranteed and coolant could leak from the cooling channel into the furnace. Such leakage of coolant fluid into the furnace should however be avoided at all cost as it may lead to a significant risk of explosion. As no such plug is welded to the cooling plate manufactured according to the method of present invention, the risk of a leakage occurring through such a plug is avoided. Furthermore, the cooling plate manufactured according to the method of present invention also presents a more important material thickness on the front face in the first edge region, as compared to cooling plates manufactured according prior art methods. The increased material thickness also contributed to a longer lifetime of the cooling plate.

[0009] Preferably, after machining excess material

from the front and rear faces of the slab, the method comprises the additional step of forming grooves and intermittent lamellar ribs in the front face of the panel-like body for anchoring a refractory brick lining.

[0010] To warrant a good anchoring function of the lamellar ribs and grooves structure on the front face of the cooling plate and a good thermal form stability of the cooling plate, the grooves are advantageously formed with a width that is narrower at an inlet of the groove than at a base of the groove. The grooves may e.g. be formed with dovetail cross-section.

[0011] Preferably, the method comprises the additional step of providing a connection pipe for each cooling channel formed in the panel-like body; aligning one end of each connection pipe with an opening to the respective cooling channel arranged in the rear face of the panel-like body; and connecting the connection pipes to the rear face of the panel-like body so as to create a fluid connection between each connection pipe and its associated cooling channel.

[0012] An adapter may be arranged between the panel-like body and the connection pipe, the adapter having the form of a hollow truncated cone. The smaller base of the adapter may have a diameter adapted for connection to the connection pipe. The larger base of the adapter is dimensioned so as to cover the whole opening of the cooling channel in the rear face. Indeed, due to the bending of the cooling channel and the subsequent machining of the rear face, the cooling channel may have an elongated opening in the rear face. The larger base of the adapter allows to ensure that a leakage at the rear face of the cooling plate can be avoided.

[0013] Preferably, the rear face of the panel-like body, the connection pipe and, if applicable, the adapter are connected together through soldering or welding.

[0014] According to a first embodiment of the invention, the method comprises the steps of providing the slab with a first cooling channel by drilling a first blind borehole into the slab, wherein the first blind borehole is drilled from the first edge towards the second edge; and providing the slab with a second cooling channel by drilling a second blind borehole into the slab, wherein the second blind borehole is drilled from the first edge towards the second edge. The first and second cooling channels are arranged in such a way that their ends in a second edge region meet and form a fluid communication between the first and second cooling channels.

[0015] The first and second blind boreholes are both drilled from the first edge towards the second edge at an angle with respect to each other, in such a way that their ends meet in the second edge region. The resulting first and second cooling channels thereby form a combined "V"-shaped cooling channel, wherein coolant flows through one of the cooling channels towards the second edge region and then, through the other one of the cooling channels, back to the first edge region. Such a "V"-shaped cooling channel allows both the inlet connection pipe and the outlet connection pipe to be arranged in the

first edge region.

[0016] According to a second embodiment of the invention, the method comprises the steps of providing the slab with a first cooling channel by drilling a first blind borehole into the slab, wherein the first blind borehole is drilled from the first edge towards the second edge; and providing the slab with a second cooling channel by drilling a second blind borehole into the slab, wherein the second blind borehole is drilled from the second edge towards the first edge. The first and second cooling channels are arranged in such a way that their ends meet and form a fluid communication between the first and second cooling channels.

[0017] The first and second blind boreholes are drilled from opposite edges towards a central region of the slab, in such a way that their ends meet in the central region. The resulting first and second cooling channels thereby form a combined cooling channel extending from the first edge to the second edge. This is of particular importance when a cooling plate with particularly important height is to be manufactured. Indeed, blind boreholes can only be drilled up to a particular depth. If the cooling channel is to exceed this depth, a second blind borehole is generally drilled from the opposite side. In this embodiment, both the first edge region and the second edge region are bent towards the rear face before removing excess material from the slab. Two cooling channel openings are thereby formed in the rear face without resorting to the necessity to provide plugs at either end of the cooling channel.

[0018] According to a third embodiment of the invention, the method comprises the steps of providing the slab with a first cooling channel by drilling a first blind borehole into the slab, wherein the first blind borehole is drilled from the first edge towards the second edge, wherein an end of the first blind borehole is arranged in a second edge region of the slab; and, in the second edge region, drilling a connecting bore extending from the rear face of the slab to the end of the first blind borehole and forming a fluid communication between the first cooling channel and the connecting bore.

[0019] In the first edge region, the slab is bent towards the rear face and an opening to the cooling channel is thereby formed in the rear face. In the second edge region on the other hand, a connecting bore is provided for forming second opening to the cooling channel. The formation of this second opening to the cooling channel essentially corresponds the method used in the prior art methods. This embodiment is adapted for connecting an inlet connection pipe in the first edge region and an outlet connection pipe in the second edge region.

[0020] Preferably, the cooling plate is made of at least one of the following materials: copper, a copper alloy or steel.

Brief Description of the Drawings

[0021] Preferred embodiments of the invention will now be described, by way of example, with reference to

the accompanying drawings, in which:

- Fig. 1 is a schematic cross-section through a slab according to a first step of the method for manufacturing a cooling plate in accordance with the present invention;
- Fig. 2 is a schematic cross-section through a slab according to a second step;
- Fig. 3 is a schematic cross-section through a slab according to a third step; and
- Fig. 4 is a schematic cross-section through a slab according to a fourth step.

Description of Preferred Embodiments

[0022] Cooling plates are used to cover the inner wall of an outer shell of a metallurgical furnace, as e.g. a blast furnace or electric arc furnace. The object of such cooling plates is to form: (1) a heat evacuating protection screen between the interior of the furnace and the outer furnace shell; and (2) an anchoring means for a refractory brick lining, a refractory guniting or a process generated accretion layer inside the furnace.

[0023] Referring now to the Figures, it will be noted that the cooling plate 10 is formed from a slab 11 e.g. made of a cast or forged body of copper, a copper alloy or steel into a panel-like body 12. This panel-like body 12, which is more closely described by referring to Fig.4 has a front face 14, also referred to as hot face, which will be facing the interior of the furnace, and a rear face 16, also referred to as cold face, which will be facing the inner surface of the furnace wall. Referring to Fig.4, the panel-like body 12 generally has the form of a quadrilateral with a pair of long edges (not shown) and a pair of short first and second edges 22, 24. Most modern cooling plates have a width in the range of 600 to 1300 mm and a height in the range of 1000 to 4200 mm. It will however be understood that the height and width of the cooling plate may be adapted, amongst others, to structural conditions of a metallurgical furnace and to constraints resulting from their fabrication process.

[0024] The cooling plate 10 further comprises connection pipes 26, 28 for a cooling fluid, generally water. These connection pipes 26, 28 are connected from the rear side of the panel-like body 12 to cooling channels 30 arranged within the panel-like body 12. As seen in Fig. 4, these cooling channels 30 extend through the panel-like body 12 in proximity of the rear face 16. According to the proposed method of manufacturing, which will be described in further detail below, such cooling channels 30 are formed by drilling. Each cooling channel 30 is normally provided with an appropriate inlet connection pipe 26, through which the cooling fluid is fed into the cooling channel 30, and/or outlet connection pipe 28, through which the cooling fluid leaves the cooling channel 30.

[0025] Referring further to Fig.4, it will be noted that the front face 14 is subdivided by means of grooves 32 into lamellar ribs 34. The grooves 32, laterally delimiting the lamellar ribs 34, may be milled into the front face 14 of the panel-like body 12. The lamellar ribs 34 extend parallel to the first and second edges 22, 24, from a first long edge (not shown) to a second long edge (not shown) of the panel-like body 12. They are perpendicular to the cooling channels 30 in the panel-like body 12. When the cooling plate 10 is mounted in the furnace, the grooves 32 and lamellar ribs 34 are arranged horizontally. They form anchorage means for anchoring a refractory brick lining, a refractory guniting or a process generated accretion layer to the front face 14.

[0026] In order to warrant an excellent anchoring for a refractory brick lining, a refractory guniting material or a process formed accretion layer to the front face 14, it should be noted that the grooves 32 have a dovetail (or swallowtail) cross-section, i.e. the inlet width of a groove 32 is narrower than the width at its base. The mean width of a lamellar rib 34 is preferably smaller than the mean width of a groove 32. Typical values for the mean width of a groove 32 are e.g. in the range of 40 mm to 100 mm. Typical values for the mean width of a lamellar rib 34 are e.g. in the range of 20 mm to 40 mm. The height of the lamellar ribs 34 (which corresponds to the depth of the grooves 32) represents generally between 20% and 40% of the total thickness of the panel-like body 12.

[0027] The method for manufacturing the cooling plates 10 will now be more closely described by referring to figures 1 to 4, which represent the cooling plates 10 at different key steps of the manufacturing method. In a first step, shown in Fig.1, a slab 11 e.g. made of a cast or forged body of copper, a copper alloy or steel is provided. Such a slab has a generally quadrilateral form with a front face 14, rear face 16, a pair of long edges (not shown) and a pair of short first and second edges 22, 24. It should be noted that the slab 11 has dimensions exceeding the desired dimensions of the panel-like body 12. At least one blind borehole 40 is drilled from the first edge 22 into the slab 11 and extends to a second edge region 42. The blind borehole 40 has an end 44 arranged in the second edge region 42. In a subsequent step of the method, illustrated by Fig.2, the slab 11 is deformed in such a way that a first edge region 46 is bent towards the rear face 16 of the slab 11. This results in a corresponding bending of the blind borehole 40. The bending angle α between a central axis 50 of the unbent blind borehole 40 and a central axis 52 of the blind borehole 40 at the first edge 22 may be between 30 and 45 degrees. This bending angle α should however not be understood as limiting. The bending angle α may e.g. vary considerably depending on the thickness of the slab 11 or the diameter of the blind borehole 40.

[0028] After the slab 11 is deformed, excess material is removed from the slab 11 along the cutting lines indicated by dotted lines 55 in Fig.2. The resulting panel-like body 12, shown in Fig.3, is again of a generally quadri-

lateral form with a front face 14, rear face 16, a pair of long edges (not shown) and a pair of short first and second edges 22, 24. A cooling channel 30, formed by the blind borehole 40, is formed in the panel-like body 12 generally parallel to the rear face 16. In the first edge region 46, the cooling channel 30 is bent and opens up into the rear face 16.

[0029] According to one embodiment of the present invention, the panel-like body 12 can be provided with a bore 60 in the second edge region 42, extending from the cooling channel 30 to the rear face 16.

[0030] After machining excess material from the slab 11, the resulting panel-like body 12 is further subjected to a milling step, wherein grooves 32 and intermittent lamellar ribs 34 are formed in the front face 14 of the panel-like body 12. As explained above, these grooves 32 and ribs 34 form anchorage means for anchoring a refractory brick lining, a refractory guniting or a process generated accretion layer to the front face 14 of the cooling plate 10.

[0031] Finally, connection pipes 26, 28 are connected to the rear face 16 of the panel-like body 12. An inlet connection pipe 26 is fluidly connected to the opening of the cooling channel 30 in the first edge region 46 for feeding cooling fluid into the cooling channel 30. An outlet connection pipe 28 is fluidly connected to the bore 60 in the second edge region 42 for evacuating cooling fluid from the cooling channel 30.

Legend of Reference Numbers:

[0032]

10	cooling plate
11	slab
12	panel-like body
14	front face
16	rear face
22	first edge
24	second edge
26	inlet connection pipe
28	outlet connection pipe
30	cooling channel
32	groove
34	rib
40	blind borehole
42	second edge region
44	end
46	first edge region
α	bending angle
50	central axis of the unbent blind borehole
52	central axis of the blind borehole at first edge
55	cutting line
60	bore

Claims

1. A method for manufacturing a cooling plate for a metallurgical furnace, said method comprising the steps of:

providing a slab of metallic material, said slab having a front face, an opposite rear face and four side edges; and

providing said slab with at least one cooling channel by drilling at least one blind borehole into said slab, wherein said blind borehole is drilled from a first edge towards an opposite second edge;

characterized by the steps of:

deforming said slab in such a way that a first edge region of said slab is at least partially bent towards said rear face of said slab; and machining excess material from said front and rear faces of said slab to produce a cooling plate having a panel-like body wherein a first opening to said cooling channel is located in said rear face

providing said cooling channel with a second opening located in said rear face.

2. The method as claimed in claim 1, wherein, after machining excess material from said front and rear faces of said slab, the method comprises the additional step of:

forming grooves and intermittent lamellar ribs in said front face of said panel-like body for anchoring a refractory brick lining.

3. The method as claimed in claim 2, wherein the grooves are formed with a width that is narrower at an inlet of the groove than at a base of the groove.

4. The method as claimed in claim 3, wherein the grooves are formed with dovetail cross-section.

5. The method as claimed in any of claims 1 to 4, wherein the method comprises the additional step of:

providing a connection pipe for each cooling channel formed in said panel-like body; aligning one end of each connection pipe with an opening to the respective cooling channel arranged in the rear face of the panel-like body; and connecting said connection pipes to said rear face of said panel-like body so as to create a fluid connection between each connection pipe and its associated cooling channel.

6. The method as claimed in claim 5, wherein an adapt-

er is arranged between said panel-like body and said connection pipe, said adapter having the form of a hollow truncated cone.

7. The method as claimed in any of claims 5 to 6, wherein said rear face of said panel-like body, said connection pipe and, if applicable, said adapter are connected together through soldering or welding. 5

8. The method as claimed in any of claims 1 to 7, comprising the steps of: 10

providing said slab with a first cooling channel by drilling a first blind borehole into said slab, wherein said first blind borehole is drilled from said first edge towards said second edge; 15
providing said slab with a second cooling channel by drilling a second blind borehole into said slab, wherein said second blind borehole is drilled from said first edge towards said second edge; 20
wherein said first and second cooling channels are arranged in such a way that their ends in a second edge region meet and form a fluid communication between said first and second cooling channels. 25

9. The method as claimed in any of claims 1 to 7, comprising the steps of: 30

providing said slab with a first cooling channel by drilling a first blind borehole into said slab, wherein said first blind borehole is drilled from said first edge towards said second edge; 35
providing said slab with a second cooling channel by drilling a second blind borehole into said slab, wherein said second blind borehole is drilled from said second edge towards said first edge; 40
wherein said first and second cooling channels are arranged in such a way that their ends meet and form a fluid communication between said first and second cooling channels. 45

10. The method as claimed in any of claims 1 to 7, comprising the steps of: 45

providing said slab with a first cooling channel by drilling a first blind borehole into said slab, wherein said first blind borehole is drilled from said first edge towards said second edge, wherein an end of said first blind borehole is arranged in a second edge region of said slab; 50
in said second edge region, drilling a connecting bore extending from said rear face of said slab to said end of said first blind borehole and forming a fluid communication between said first cooling channel and said connecting bore. 55

11. The method as claimed in any one of the above claims, wherein said cooling plate is made of at least one of the following materials: copper, a copper alloy or steel.

Patentansprüche

1. Verfahren zur Herstellung einer Kühlplatte für einen metallurgischen Ofen, wobei das Verfahren die folgenden Schritte umfasst:

Bereitstellen einer Bramme aus metallischem Material, wobei die Bramme eine Vorderseite, eine gegenüberliegende Rückseite und vier Seitenkanten aufweist; und

Versehen der Bramme mit mindestens einem Kühlkanal durch Bohren von mindestens einem Sackloch in die Bramme, wobei das Sackloch von einer ersten Kante in Richtung einer gegenüberliegenden zweiten Kante gebohrt wird;

gekennzeichnet durch die folgenden Schritte:

Verformen der Bramme derart, dass ein erster Kantenbereich der Bramme zumindest teilweise in Richtung der Rückseite der Bramme gebogen wird; und

Abspannen überschüssigen Materials von der Vorder- und Rückseite der Bramme, um eine Kühlplatte mit einem plattenartigen Körper herzustellen, bei dem eine erste Öffnung zu dem Kühlkanal in der Rückseite angeordnet ist, Versehen des Kühlkanals mit einer zweiten Öffnung, die in der Rückseite angeordnet ist.

2. Verfahren nach Anspruch 1, wobei das Verfahren nach dem Abspannen überschüssigen Materials von der Vorder- und Rückseite der Bramme den folgenden zusätzlichen Schritt umfasst:

Bilden von Nuten und dazwischen angeordneten lamellenartigen Rippen in der Vorderseite des plattenartigen Körpers zum Verankern einer feuerfesten Steinauskleidung.

3. Verfahren nach Anspruch 2, wobei die Nuten mit einer Breite gebildet werden, die an einer Öffnung der Nut schmaler als an einer Basis der Nut ist.

4. Verfahren nach Anspruch 3, wobei die Nuten mit schwalbenschwanzförmigem Querschnitt gebildet werden.

5. Verfahren nach irgendeinem der Ansprüche 1 bis 4, wobei das Verfahren den folgenden zusätzlichen Schritt umfasst:

Bereitstellen eines Verbindungsrohrs für jeden in dem plattenartigen Körper ausgebildeten Kühlkanal;

Ausrichten eines Endes jedes Verbindungsrohrs auf eine Öffnung zu dem jeweiligen Kühlkanal, die in der Rückseite des plattenartigen Körpers angeordnet ist; und

Verbinden der Verbindungsrohre mit der Rückseite des plattenartigen Körpers derart, dass eine Fluidverbindung zwischen jedem Verbindungsrohr und dessen zugeordnetem Kühlkanal gebildet wird.

6. Verfahren nach Anspruch 5, wobei ein Zwischenstück zwischen dem plattenartigen Körper und dem Verbindungsrohr angeordnet wird, wobei das Zwischenstück die Form eines hohlen Kegelstumpfs aufweist.

7. Verfahren nach irgendeinem der Ansprüche 5 bis 6, wobei die Rückseite des plattenartigen Körpers, das Verbindungsrohr und gegebenenfalls das Zwischenstück durch Verlöten oder Verschweißen miteinander verbunden werden.

8. Verfahren nach irgendeinem der Ansprüche 1 bis 7, umfassend die folgenden Schritte:

Versehen der Bramme mit einem ersten Kühlkanal durch Bohren eines ersten Sacklochs in die Bramme, wobei das erste Sackloch von der ersten Kante in Richtung der zweiten Kante gebohrt wird;

Versehen der Bramme mit einem zweiten Kühlkanal durch Bohren eines zweiten Sacklochs in die Bramme, wobei das zweite Sackloch von der ersten Kante in Richtung der zweiten Kante gebohrt wird;

wobei der erste und zweite Kühlkanal derart angeordnet werden, dass ihre Enden in einem zweiten Kantenbereich zusammentreffen und eine Fluidverbindung zwischen dem ersten und zweiten Kühlkanal bilden.

9. Verfahren nach irgendeinem der Ansprüche 1 bis 7, umfassend die folgenden Schritte:

Versehen der Bramme mit einem ersten Kühlkanal durch Bohren eines ersten Sacklochs in die Bramme, wobei das erste Sackloch von der ersten Kante in Richtung der zweiten Kante gebohrt wird;

Versehen der Bramme mit einem zweiten Kühlkanal durch Bohren eines zweiten Sacklochs in die Bramme, wobei das zweite Sackloch von der zweiten Kante in Richtung der ersten Kante gebohrt wird;

wobei der erste und zweite Kühlkanal derart an-

geordnet werden, dass ihre Enden zusammentreffen und eine Fluidverbindung zwischen dem ersten und zweiten Kühlkanal bilden.

10. Verfahren nach irgendeinem der Ansprüche 1 bis 7, umfassend die folgenden Schritte:

Versehen der Bramme mit einem ersten Kühlkanal durch Bohren eines ersten Sacklochs in die Bramme, wobei das erste Sackloch von der ersten Kante in Richtung der zweiten Kante gebohrt wird, wobei ein Ende des ersten Sacklochs in einem zweiten Kantenbereich der Bramme angeordnet wird;

in dem zweiten Kantenbereich, Bohren einer Verbindungsbohrung, die sich von der Rückseite der Bramme zum Ende des ersten Sacklochs erstreckt und eine Fluidverbindung zwischen dem ersten Kühlkanal und der Verbindungsbohrung bildet.

11. Verfahren nach irgendeinem der vorangehenden Ansprüche, wobei die Kühlplatte aus mindestens einem der folgenden Materialien besteht: Kupfer, einer Kupferlegierung oder Stahl.

Revendications

1. Procédé de fabrication d'une plaque de refroidissement pour un four métallurgique, ledit procédé comprenant les étapes de :

prévoir une plaque de matériau métallique, ladite plaque ayant une face avant, une face arrière opposée et quatre bords latéraux ; et prévoir ladite plaque avec au moins un canal de refroidissement en perçant au moins un trou borgne foré dans ladite plaque, dans laquelle ledit trou borgne foré est percé d'un premier bord vers un deuxième bord opposé ;

caractérisé par les étapes de :

déformer ladite plaque de telle manière qu'une première région de bord de ladite plaque est au moins partiellement repliée vers ladite face arrière de ladite plaque ; et usiner le matériau en excès desdites faces avant et arrière de ladite plaque pour produire une plaque de refroidissement ayant un corps semblable à un panneau dans laquelle une ouverture sur ledit canal de refroidissement est située dans ladite face arrière

fournir ledit canal de refroidissement d'une seconde ouverture située dans ladite face arrière.

2. Procédé selon la revendication 1, dans lequel, après usinage du matériau en excès desdites faces avant et arrière de ladite plaque, le procédé comprend l'étape supplémentaire de :

former des rainures et des nervures lamellaires intermittentes dans ladite face avant dudit corps semblable à un panneau pour ancrer un revêtement de briques réfractaires.

3. Procédé selon la revendication 2, dans lequel les rainures sont formées avec une largeur qui est plus étroite à une entrée de la rainure qu'à une base de la rainure.

4. Procédé selon la revendication 3, dans lequel les rainures sont formées avec une section transversale en queue d'aronde.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel le procédé comprend l'étape supplémentaire de :

prévoir un tuyau de connexion pour chaque canal de refroidissement formé dans ledit corps semblable à un panneau ;
aligner une extrémité de chaque tuyau de connexion avec une ouverture sur le canal de refroidissement respectif agencé dans la face arrière du corps semblable à un panneau ; et
connecter lesdits tuyaux de connexion à ladite face arrière dudit corps semblable à un panneau de manière à créer une connexion de fluide entre chaque tuyau de connexion et son canal de refroidissement associé.

6. Procédé selon la revendication 5, dans lequel un adaptateur est agencé entre ledit corps semblable à un panneau et ledit tuyau de connexion, ledit adaptateur ayant la forme d'un cône tronqué creux.

7. Procédé selon l'une quelconque des revendications 5 à 6, dans lequel ladite face arrière dudit corps semblable à un panneau, ledit tuyau de connexion et, si applicable, ledit adaptateur sont connectés ensemble par brasage ou soudage.

8. Procédé selon l'une quelconque des revendications 1 à 7, comprenant les étapes de :

prévoir ladite plaque avec un premier canal de refroidissement en perçant un premier trou borgne foré dans ladite plaque, dans lequel ledit premier trou borgne foré est percé dudit premier bord vers ledit deuxième bord ;
prévoir ladite plaque avec un deuxième canal de refroidissement en perçant un deuxième trou borgne foré dans ladite plaque, dans lequel ledit

deuxième trou borgne foré est percé dudit premier bord vers ledit deuxième bord ;

dans lequel lesdits premier et deuxième canaux de refroidissement sont agencés de telle manière que leurs extrémités dans une deuxième région de bord se rencontrent et forment une communication de fluide entre lesdits premier et deuxième canaux de refroidissement.

9. Procédé selon l'une quelconque des revendications 1 à 7, comprenant les étapes de :

prévoir ladite plaque avec un premier canal de refroidissement en perçant un premier trou borgne foré dans ladite plaque, dans lequel ledit premier trou borgne foré est percé dudit premier bord vers ledit deuxième bord ;
prévoir ladite plaque avec un deuxième canal de refroidissement en perçant un deuxième trou borgne foré dans ladite plaque, dans lequel ledit deuxième trou borgne foré est percé dudit deuxième bord vers ledit premier bord ;
dans lequel lesdits premier et deuxième canaux de refroidissement sont agencés de telle manière que leurs extrémités se rencontrent et forment une communication de fluide entre lesdits premier et deuxième canaux de refroidissement.

10. Procédé selon l'une quelconque des revendications 1 à 7, comprenant les étapes de :

prévoir ladite plaque avec un premier canal de refroidissement en perçant un premier trou borgne foré dans ladite plaque, dans lequel ledit premier trou borgne foré est percé dudit premier bord vers ledit deuxième bord, dans lequel une extrémité dudit premier trou borgne foré est agencée dans une deuxième région de bord de ladite plaque ;
dans ladite deuxième région de bord, percer un trou de connexion s'étendant de ladite face arrière de ladite plaque jusqu'à ladite extrémité dudit premier trou borgne foré et former une communication de fluide entre ledit premier canal de refroidissement et ledit trou de connexion.

11. Procédé selon l'une quelconque des revendications précédentes, dans lequel ladite plaque de refroidissement est constituée d'au moins l'un des matériaux suivants : du cuivre, un alliage de cuivre ou de l'acier.

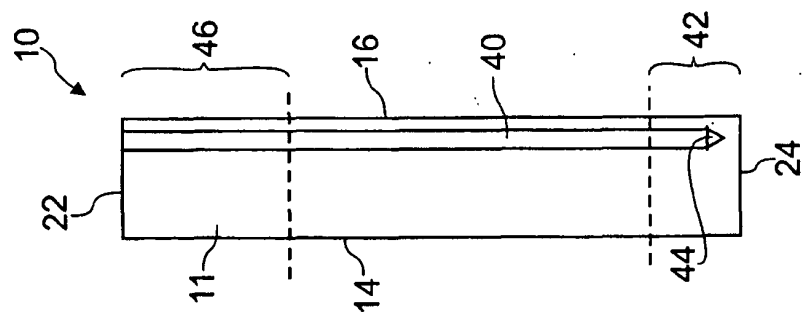


Fig. 1

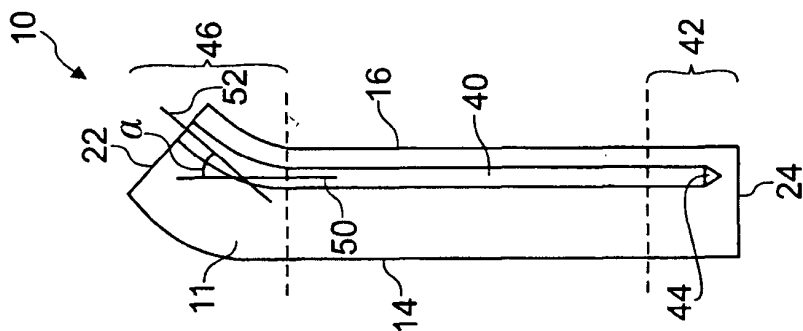


Fig. 2

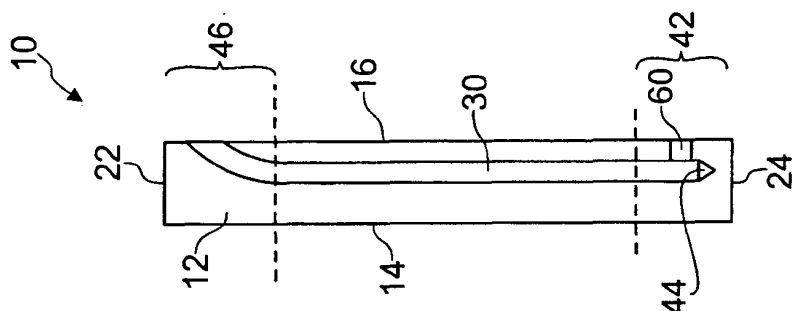


Fig. 3

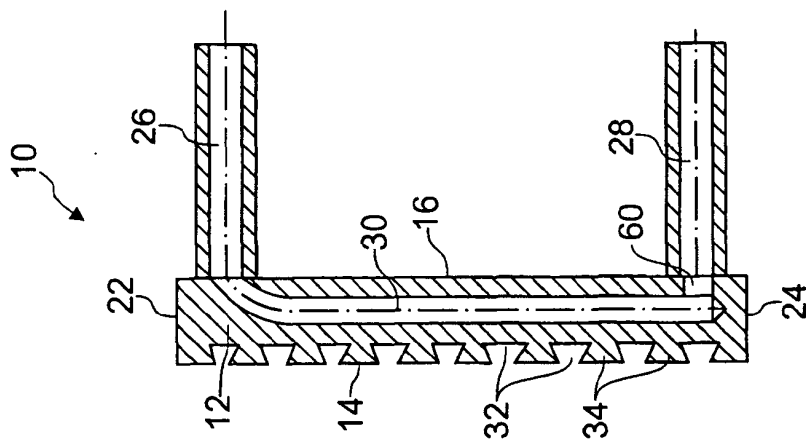


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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