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(54) BRAZING METHOD

LÖTVERFAHREN

PROCÉDÉ DE BRASAGE

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Description

FIELD OF THE INVENTION

[0001] The present invention is directed to a brazing method. More specifically, the present invention is directed to brazing methods for forming cooling microchannels.

BACKGROUND OF THE INVENTION

[0002] JP-A-2010274311 discloses forming grooves on either side of a plate, arranging filling parts inside the grooves, melting a joining material to join a plate and removing the filling parts from the grooves.

[0003] Turbine systems are continuously being modified to increase efficiency and decrease cost. One method for increasing the efficiency of a turbine system includes increasing the operating temperature of the turbine system. To increase the temperature, the turbine system must be constructed of materials which can withstand such temperatures during continued use.

[0004] In addition to modifying component materials and coatings, the temperature capability of a turbine component may be increased through the use of cooling microchannels. The cooling microchannels can be incorporated into metals and alloys used in high temperature regions of gas turbines. However, forming an exterior cover over the cooling microchannels can be difficult as thermal spraying directly over the channel can result in coating material filling the channel. One method to prevent the coating material from filling the channel includes filling the channel with a sacrificial material prior to coating, then coating the component and subsequently leeching out the sacrificial material. The filling and removing of the sacrificial material can be both difficult and expensive.

[0005] As an alternative to filling and leeching, a thin cover layer can be brazed to the substrate, over the cooling microchannel. However, during the brazing of materials to a surface of the substrate, the brazing temperatures required to sufficiently braze the material may also soften the braze cover material. The softened material can sag or droop into the cooling microchannels, blocking them as they harden. As such, brazing requires a very narrow temperature range, outside of which the component can be damaged or made unusable.

[0006] A brazing method that does not suffer from one or more of the above drawbacks would be desirable in the art.

BRIEF DESCRIPTION OF THE INVENTION

[0007] The present invention is defined in the accompanying claims.

[0008] In one embodiment, a brazing method includes providing a substrate having at least one groove. Next, a support member is provided and positioned over the at least one groove in the substrate. A braze material is provided and applied over the support member, the support member and the braze material forming a first braze assembly. Next, the first braze assembly is heated to braze the first braze assembly to the substrate.

[0009] In another exemplary embodiment, a brazing method includes providing a preform, providing a mesh, pressing the mesh into the preform, heating the preform to form a second braze assembly, providing a substrate, providing at least one groove in the substrate, applying the second braze assembly over the at least one groove in the substrate, then brazing the second braze assembly to the substrate.

[0010] In another exemplary embodiment, a brazing method includes providing a braze material, forming at least one groove in the braze material, securing support members within the at least one groove to form a third braze assembly, providing a substrate, applying the third braze assembly over the substrate, and brazing the third braze assembly to the substrate to form a brazed article. The at least one groove in the third braze assembly forms at least one cooling microchannel in the brazed article.

[0011] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a flow chart of a brazing method according to an embodiment of the disclosure.

FIG. 2 is a process view of a brazing method according to an embodiment of the disclosure.

FIG. 3 is a process view of a brazing method according to an embodiment of the disclosure.

FIG. 4 is a flow chart of a brazing method according to an embodiment of the disclosure.

FIG. 5 is a process view of a brazing method according to an embodiment of the disclosure.

FIG. 6 is a flow chart of a brazing method according to an embodiment of the disclosure.

FIG. 7 is a process view of a brazing method according to an embodiment of the disclosure.

FIG. 8 is a process view of a brazing method according to an embodiment of the disclosure.

FIG. 9 is a process view of a prior art brazing method showing a braze material forming a convex border within a groove in a substrate.

[0013] Wherever possible, the same reference numbers will be used throughout the drawings to represent the same parts.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Provided is an exemplary brazing method. Embodiments of the present disclosure, in comparison to processes and articles not using one or more of the features disclosed herein, increase efficiency of cooling microchannel formation, decrease cost of cooling microchannel formation, decrease encroachment of braze material into cooling microchannels during brazing, permit increased brazing temperatures, decrease scrap rate during brazing, permit formation of cooling microchannels in the braze material, or a combination thereof.

[0015] Referring to FIG. 1 and FIG. 2, in one embodiment, a brazing method 100 includes providing a substrate 101 having at least one groove 103, providing a support member 105, positioning the support member 105 over the groove 103 in the substrate 101 (step 110), providing a braze material 107, applying the braze material 107 over the support member 105 (step 120) to form a first braze assembly 109 comprising the support member 105 and the braze material 107, and heating the first braze assembly 109 (step 130) to braze the first braze assembly 109 to the substrate 101. In another embodiment, the braze material 107 may be formed with a thickness of up to 30 mils, up to 25 mils, up to 20 mils, or a combination thereof. The brazing is performed by any suitable braze method capable of securing the braze material 107 of the first braze assembly 109 to the substrate 101 to form a brazed article. Each of the at least one grooves 103 in substrate 101 forms a cooling microchannel 104 in the brazed article. Suitable braze methods include, but are not limited to, vacuum brazing, atmospheric brazing, brazing in a non-oxidizing atmosphere, or a combination thereof. The braze material 107 includes any suitable material such as, but not limited to, a nickel-based braze alloy.

[0016] Referring to FIG. 3, in one embodiment, the first braze assembly 109 also may be intermediate the substrate 101 having the groove 103, and a second substrate 102 comprising the same material. In this embodiment, not only does the first braze assembly 109 prevent sagging, slumping, or drooping of the braze material 107 into the groove 103, but the first braze assembly 109 joins the substrate 101 having the groove 103 to the second substrate 102. Referring to FIG. 9, sagging, slumping, or drooping, as used herein, refers to the braze material 107 entering the groove 103 and forming a convex border within the groove 103.

[0017] During the heating of the first braze assembly 109 (step 130), a braze temperature softens the braze material 107, which otherwise may sag, slump, or droop into the groove 103 under its own weight without support. However, positioning of the support member 105 over the groove 103 (step 110) maintains the braze material 107 above the groove 103, minimizing, reducing, or eliminating the sagging, slumping, or drooping of the braze material 107. Additionally, the support member 105 reduces or eliminates scrap formation from an application utilizing increased heat to the braze material 107 by reducing or eliminating the sagging or drooping of the braze material 107 into the groove 103. The support member 105 may be any suitable article capable of maintaining the braze material 107 above the groove 103 during the heating of the first braze assembly 109 (step 130). Suitable articles for the support member 105 include, but are not limited to, a rod, a wire, a mesh 201 (FIG. 2), a solid sheet, a perforated sheet, or a combination thereof. The support member 105 preferably should have a sufficiently high melting temperature to survive brazing. However, support member 105 may be incorporated into the brazed article or may degrade within the brazed article during the life of the turbine.

[0018] The positioning of the support member 105 over the groove 103 (step 110) to reduce or eliminate the slumping, sagging, or drooping of the softened braze material 107 permits brazing temperatures to be achieved without the braze material 107 entering the groove 103. In one embodiment, the support member 105 may be assimilated into the braze material 107 by the increased brazing temperatures during the heating of the first braze assembly 109 (step 130). In one embodiment, the support member 105 has a higher melting and softening temperature than temperature of the braze material 107 and is incorporated into a brazed article. The support member 105 that can withstand the heating of the first braze assembly 109 (step 130) includes any suitable composition that is not softened at brazing temperatures. Suitable compositions include those that are similar or substantially similar to the substrate 101, such as, but not limited to, ceramics, metal alloys, or a combination thereof. Support members that may degrade include materials that may oxidize during high temperature turbine operations, such as steel.

[0019] The cooling microchannel 104 forms between the substrate 101 and the first braze assembly 109. The cooling microchannel 104 includes an open interior space to permit the flow of a fluid therein. Reducing or eliminating the sagging or drooping of the softened braze material 107 into the open interior space of the cooling microchannel 104 permits unimpeded flow of cooling fluid. In one embodiment, the cooling microchannel 104 includes a width and/or depth of, but not limited to, between about 5 mils and about 200 mils, between about 10 mils and about 150 mils, between about 10 mils and about 100 mils, or any combination, sub-combination, range, or sub-range thereof wherein one mil equals 0.001 inches. In another embodiment, the width and/or depth of the cooling microchannel 104 varies between channels or along the cooling microchannel 104 itself. In a further embodiment, the cooling microchannel 104 includes any suitable cross-sectional shape such as, but not limited to, a circle, a semi-circle, a square, a rectangle, an oval, a triangle, any other polygonal shape, or a combination thereof.

[0020] The substrate 101 includes any component utilizing the cooling microchannel 104 therein such as, but not limited to, a bucket, a nozzle, a shroud, a hot gas path component, or combustor. In one embodiment, the first braze assembly 109 is shaped prior to heating (step 130) to conform with the shape of the substrate 101 so that the fluid flowing through the cooling microchannel 104 does not leak. The substrate includes any suitable brazeable composition such as, but not limited to, a nickel-based alloy, a cobalt-based alloy, a high-strength steel alloy, or a combination thereof. In a gas turbine, the substrate 101 having the cooling microchannel 104 is exposed to operational temperatures of between about 1600° F and about 2400° F, between about 1700° F and about 2300° F, between about 1800° F and about 2200° F, or any combination, sub-combination, range, or sub-range thereof. Providing the braze material 107 having a similar or substantially similar coefficient of thermal expansion to the substrate may reduce stress from differential expansion during operation.

[0021] Referring to FIG. 4 and FIG. 5, in one embodiment, the mesh 201 is pressed (step 210) into a preform 203 in a "green" state prior a sintering operation, then heated (step 220) to form a second braze assembly 209. In another embodiment, the mesh 201 is pressed (step 210) in between two (2) or more layers of the preform 203 then heated (step 220) to form the second braze assembly 209.

[0022] In one embodiment, prior to heating (step 220), the preform 203 in the "green" state forms a felt-type material. The preform 203 includes at least a high-melting alloy, a low-melting alloy, and a binder. In another embodiment, both the high-melting alloy and the low-melting alloy are in powdered form held together by the binder. Heating (step 220) of the preform 203 sinters the preform 203, volatilizing or burning the binder and securing the high-melting alloy, the low-melting alloy, and the mesh 201 to each other. The heating (step 220) is performed at any suitable temperature below the brazing temperature of the preform 203, but sufficiently high to coalesce the high-melt alloy powder and the low-melt alloy powder with minimal melting of the low-melt alloy. Additionally, in another embodiment, the heating (step 220) of the preform 203 provides incipient melting of the low-melt alloy which provides for binding of the high melt alloy and mesh 201. Suitable temperatures include, but are not limited to, between about 1700° F and about 2200° F, between about 1800° F and about 2000° F, between about 1850° F and about 1950° F, or any combination, sub-combination, range, or sub-range thereof. The high-melting alloy may be similar or substantially similar to the substrate 101. The low-melting alloy includes materials which melt below the high-melting material or the substrate, for example around 2000° F.

[0023] In one embodiment, the low-melting alloy has a composition characterized by a nominal weight percentage of between about 8.0% and about 8.7% Cr, between about 9% and about 10% Co, between about 5.25% and about 5.75% Al, up to about 0.9% Ti (for example, between about 0.6% and about 0.9%), between about 9.3% and about 9.7% W, up to about 0.6% Mo (for example, between about 0.4% and about 0.6%), between about 2.8% and about 3.3% Ta, between about 1.3% and about 1.7% Hf, up to about 0.1% C (for example, between about 0.07% and about 0.1%), up to about 0.02% Zr (for example, between about 0.005% and about 0.02%), up to about 0.02% B (for example, between about 0.01% and about 0.02%), up to about 0.2% Fe, up to about 0.12% Si, up to about 0.1 % Mn, up to about 0.1 % Cu, up to about 0.01 % P, up to about 0.004% S, up to about 0.1% Nb, and a balance of nickel. In another embodiment, the low-melting alloy has a composition characterized by a nominal weight percentage of about 19.0 percent chromium, about 0.03 percent boron, about 10 percent silicon, about 0.1 percent carbon, and balance nickel.

[0024] In one embodiment, the high-melting alloy has a composition characterized by a nominal weight percentage of about 12 percent cobalt, about 6.8 percent chromium, about 4.9 percent tungsten, about 1.5 percent molybdenum, about 6.1 percent aluminum, about 6.3 percent tantalum, about 0.12 percent carbon, about 2.8 percent rhenium, about 1.2 percent hafnium, and balance nickel.

[0025] The second braze assembly 209 is applied over the groove 103 in the substrate 101 (step 230) and brazed (step 240) to the substrate 101. The mesh 201 increases the rigidity of the second braze assembly 209, reducing or eliminating slumping, sagging, and/or drooping into the groove 103 during the brazing (step 240). The brazing (step 240) of the second braze assembly 209 over the groove 103 forms a cover over the cooling microchannel 104 in the substrate 101. The mesh 201 remains within the second braze assembly 209 forming a portion of the brazed article, or is assimilated during the brazing or during subsequent operation of the turbine (step 240). In one embodiment, the second braze assembly 209 is shaped prior to brazing (step 240) to conform with the shape of the substrate 101 so that the fluid flowing through the cooling microchannel 104 does not leak.

[0026] Referring to FIG. 6 and FIG. 7, in one embodiment, at least one of the grooves 103 is formed (step 310) in the braze material 107 and support members 301 are secured (step 320) within the groove 103 in the braze material 107 to form a third braze assembly 309. In one embodiment, the support members 301 include the same material as the substrate 101, and have a melting temperature above the brazing temperature of the braze material 107. The support members 301 are secured (step 320) in any suitable position within the groove 103 to reduce or eliminate slumping, sagging, and/or drooping of the braze material 107 into the groove 103. Suitable positions include, but are not limited to, side portions 303 of the groove 103, a top portion 305 of the groove 103, or a combination thereof.

[0027] After securing (step 320) the support members 301 within the groove 103, the third braze assembly 309 is applied (step 330) over the substrate 101. The third braze assembly 309 is shaped prior to applying (step 330) to conform with the shape of the substrate 101 so that the fluid flowing through the cooling microchannel 104 does not leak. In one embodiment, when the third braze assembly 309 is applied (step 330), at least one of the grooves 103 in the third braze assembly 309 is positioned to correspond with at least one of the grooves 103 in the substrate 101. Together, the corresponding grooves 103 between the third braze assembly 309 and the substrate 101 form the cooling microchannels 104. In another embodiment, when the third braze assembly 309 is applied (step 330), at least one of the grooves 103 in the third braze assembly 309 is positioned such that it does not correspond with the at least one groove 103 in the substrate 101. Each non-corresponding groove 103 in either the substrate 101 or the third braze assembly 309 forms a separate microchannel 104. In an alternate embodiment, the substrate 101 does not include the grooves 103. Applying (step 330) the third braze assembly 309 over the substrate 101 without the grooves 103 permits the formation of the cooling microchannels 104 without forming the grooves 103 in the substrate 101.

[0028] Referring to FIG. 8, in an alternate embodiment, the support members 301 include a single metal form positioned and/or secured within the groove 103 in the braze material 107 to form the third braze assembly 309. For example, in one embodiment, the support member 301 is a microtube 311 positioned within the groove 103. The microtube 311 has a higher melting temperature than the braze material 107, and is secured (step 320) within the groove 103 during the brazing (step 340) of the third braze assembly 309 to the substrate 101. The microtube 311 secured within the groove 103 forms the microchannel 104 in the brazed article. The microtube 311 includes any suitable shape such as, but not limited to, circular, square, rectangular, triangular, any other polygonal shape, or a combination thereof. In another embodiment, the shape and/or size of the microtube 311 is varied along the length of the microtube 311.

[0029] The support members 301 include any suitable material for maintaining the shape of the groove 103 during the brazing (step 340). Suitable materials include, but are not limited to, ceramics, metal alloys, or a combination thereof. For example, in one embodiment, the support members 301 include ceramic, and are not brazed (step 340) to the substrate 101 during the elevated temperature brazing (step 340). In another example, the support members 301 include metal alloys and both the braze material 107 of the third braze assembly 309 and the support members 301 are brazed (step 340) to the substrate 101 during the elevated temperature brazing (step 340).

[0030] While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A brazing method, comprising:

providing a substrate (101) having at least one groove (103);
providing a support member (105);
positioning the support member (105) over the at least one groove (103) in the substrate (101);
providing a braze material (107) including a preform comprising a high-melting alloy, a low-melting alloy, and a binder;
applying the braze material (107) over the support member (105), the braze material and the support member forming a first braze assembly (109); and
heating the first braze assembly (109) to braze the first braze assembly to the substrate (101) wherein heating the first braze assembly (109) sinters the preform and brazes the first braze assembly (109) to the substrate (101).

2. The brazing method of claim 1, comprising maintaining the braze material (107) above the at least one groove (103) without the braze material entering the groove (103) and forming a convex border.

3. The brazing method of claim 1 or claim 2, further comprising the steps of:

providing a second substrate (102); and
positioning the second substrate (102) over the first braze assembly (109) so that the first braze assembly (109) is intermediate the substrate (101) having the at least one groove (103) and the second substrate (102);
wherein the heating step brazes the second substrate (102) to the substrate (101) having the at least one groove (103).

4. The brazing method of any preceding claim, wherein each of the at least one grooves (103) forms a cooling microchannel with unimpeded flow between the substrate (101) and the braze assembly (109).

5. The brazing method of any preceding claim, wherein the braze material (107) comprises a nickel-based braze alloy.

6. The brazing method of any preceding claim, wherein the braze material (107) includes a coefficient of thermal expansion compatible with the coefficient of thermal expansion of the substrate (101).

7. The brazing method of any preceding claim, wherein the support member (105) is a wire or a mesh.

8. The brazing method of any preceding claim, further comprising:

   applying the preform over the support member (105) to form the first braze assembly (109).

9. The brazing method of any preceding claim, wherein the substrate (101) comprises a nickel-based alloy or a cobalt-based alloy.

10. The brazing method of claim 1, further comprising:

   providing a mesh (201);
   pressing the mesh into the preform (203);
   heating the preform to form a second braze assembly;
   applying the second braze assembly over the at least one groove (103) in the substrate (101); then
   brazing the second braze assembly to the substrate.

11. A brazing method, comprising:

   providing a braze material (107);
   forming at least one groove (103) in the braze material (107);
   securing support members (301) within the at least one groove (103) to form a third braze assembly;
   providing a substrate (101);
   applying the third braze assembly over the substrate (101); and
   brazing the third braze assembly to the substrate to form a brazed article;
   wherein each of the at least one grooves (103) forms a cooling microchannel in the brazed article.

12. The brazing method of claim 11, wherein the support members are ceramics.

13. The brazing method of claim 11 or claim 12, wherein the support members are microtubes (311).

14. The brazing method of claim 13, wherein the microtube (311) forms the microchannel in the brazed article.

Patentansprüche

1. Hartlötverfahren, das Folgendes umfasst:

   Bereitstellen eines Substrats (101), das wenigstens eine Nut (103) besitzt;
   Bereitstellen eines Trägerelements (105);
   Positionieren des Trägerelements (105) über der wenigstens einen Nut (103) in dem Substrat (101);
   Bereitstellen eines Hartlötmaterials (107), das eine Vorform enthält, die eine hochschmelzende Legierung, eine niedrigschmelzende Legierung und ein Bindemittel umfasst;
   Aufbringen des Hartlötmaterials (107) auf das Trägerelement (105), wobei das Hartlötmaterial und das Trägerelement eine erste Hartlötanordnung (109) bilden; und
   Erhitzen der ersten Hartlötanordnung (109), um die erste Hartlötanordnung an das Substrat (101) hartzulöten, wobei das Erhitzen der ersten Hartlötanordnung (109) die Vorform sintert und die erste Hartlötanordnung (109) an das Substrat (101) hartlötet.

2. Hartlötverfahren nach Anspruch 1, das das Halten des Hartlötmaterials (107) über der wenigstens einen Nut (103), ohne dass Hartlötmaterial in die Nut (103) eintritt und einen konvexen Rand bildet, umfasst.

3. Hartlötverfahren nach Anspruch 1 oder Anspruch 2, das ferner die folgenden Schritte umfasst:

   Bereitstellen eines zweiten Substrats (102); und
   Positionieren des zweiten Substrats (102) über der ersten Hartlötanordnung (109), so dass sich die erste Hartlötanordnung (109) zwischen dem Substrat (101), das die wenigstens eine Nut (103) besitzt, und dem zweiten Substrat (102) befindet;
   wobei der Heizschritt das zweite Substrat (102) an das Substrat (101), das die wenigstens eine Nut (103) besitzt, hartlötet.

4. Hartlötverfahren nach einem vorhergehenden Anspruch, wobei jede der wenigstens einen Nut (103) einen Kühlungsmikrokanal mit unbehinderter Strömung zwischen dem Substrat (101) und der Hartlötanordnung (109) bildet.

5. Hartlötverfahren nach einem vorhergehenden Anspruch, wobei das Hartlötmaterial (107) eine Hartlötlegierung auf Nickelbasis enthält.

6. Hartlötverfahren nach einem vorhergehenden Anspruch, wobei das Hartlötmaterial (107) einen Wärmeausdehnungskoeffizienten besitzt, der mit dem Wärmeausdehnungskoeffizienten des Substrats (101) kompatibel ist.

7. Hartlötverfahren nach einem vorhergehenden Anspruch, wobei das Trägerelement (105) ein Draht oder ein Gitter ist.

8. Hartlötverfahren nach einem vorhergehenden Anspruch, das ferner Folgendes umfasst:

   Anbringen der Vorform über dem Trägerelement (105), um die erste Hartlötanordnung (109) zu bilden.

9. Hartlötverfahren nach einem vorhergehenden Anspruch, wobei das Substrat (101) eine Legierung auf Nickelbasis oder eine Legierung auf Kobaltbasis enthält.

10. Hartlötverfahren nach Anspruch 1, das ferner Folgendes umfasst:

    Bereitstellen eines Gitters (201);
    Pressen des Gitters in die Vorform (203);
    Erhitzen der Vorform, um eine zweite Hartlötanordnung zu bilden;
    Anbringen der zweiten Hartlötanordnung über der wenigstens einen Nut (103) in dem Substrat (101); dann
    Hartlöten der zweiten Hartlötanordnung an das Substrat.

11. Hartlötverfahren, das Folgendes umfasst:

    Bereitstellen eines Hartlötmaterials (107);
    Bilden wenigstens einer Nut (103) in dem Hartlötmaterial (107);
    Befestigen von Trägerelementen (301) in der wenigstens einen Nut (103), um eine dritte Hartlötanordnung zu bilden;
    Bereitstellen eines Substrats (101);
    Anbringen der dritten Hartlötanordnung über dem Substrat (101); und
    Hartlöten der dritten Hartlötanordnung an das Substrat, um einen hartgelöteten Gegenstand zu bilden;
    wobei jede der wenigstens einen Nut (103) einen Kühlungsmikrokanal in dem hartgelöteten Gegenstand bildet.

12. Hartlötverfahren nach Anspruch 11, wobei die Trägerelemente Keramiken sind.

13. Hartlötverfahren nach Anspruch 11 oder Anspruch 12, wobei die Trägerelemente Mikroröhren (311) sind.

14. Hartlötverfahren nach Anspruch 13, wobei die Mikroröhre (311) den Mikrokanal in dem hartgelöteten Gegenstand bildet.

Revendications

1. Procédé de brasage, comprenant les étapes suivantes :

   se procurer un substrat (101) ayant au moins une rainure (103) ;
   se procurer un élément de support (105) ;
   positionner l'élément de support (105) sur l'au moins une rainure (103) dans le substrat (101) ;
   se procurer un matériau de brasage (107) comportant une préforme comprenant un alliage à haut point de fusion, un alliage à bas point de fusion, et un liant ;
   appliquer le matériau de brasage (107) sur l'élément de support (105), le matériau de brasage et l'élément de support formant un premier ensemble de brasage (109) ; et
   chauffer le premier ensemble de brasage (109) pour braser le premier ensemble de brasage au substrat (101), le chauffage du premier ensemble de brasage (109) frittant la préforme et brasant le premier ensemble de brasage (109) au substrat (101).

2. Procédé de brasage de la revendication 1, comprenant le maintien du matériau de brasage (107) au-dessus de l'au moins une rainure (103) sans que le matériau de brasage pénètre dans la rainure (103) et forme une bordure convexe.

3. Procédé de brasage de la revendication 1 ou la revendication 2, comprenant en outre les étapes consistant à :

   se procurer un deuxième substrat (102) ; et
   positionner le deuxième substrat (102) sur le premier ensemble de brasage (109) de telle sorte que le premier ensemble de brasage (109) soit intercalé entre le substrat (101) ayant l'au moins une rainure (103) et le deuxième substrat (102) ;
   dans lequel l'étape de chauffage brase le deuxième substrat (102) au substrat (101) ayant l'au moins une rainure (103).

4. Procédé de brasage d'une quelconque revendication précédente, dans lequel la ou chacune des rainures (103) forme un microcanal de refroidissement avec libre passage entre le substrat (101) et l'ensemble de brasage (109).

5. Procédé de brasage d'une quelconque revendication précédente, dans lequel le matériau de brasage (107) comprend un alliage de brasage à base de nickel.

6. Procédé de brasage d'une quelconque revendication précédente, dans lequel le matériau de brasage (107) présente un coefficient de dilatation thermique compatible avec le coefficient de dilatation thermique du substrat (101).

7. Procédé de brasage d'une quelconque revendication précédente, dans lequel l'élément de support (105) est un fil ou un treillis.

8. Procédé de brasage d'une quelconque revendication précédente, comprenant en outre l'étape suivante :

   appliquer la préforme sur l'élément de support (105) pour former le premier ensemble de brasage (109).

9. Procédé de brasage d'une quelconque revendication précédente, dans lequel le substrat (101) comprend un alliage à base de nickel ou un alliage à base de cobalt.

10. Procédé de brasage de la revendication 1, comprenant en outre les étapes suivantes :

    se procurer un treillis (201) ;
    appuyer le treillis dans la préforme (203) ;
    chauffer la préforme pour former un deuxième ensemble de brasage ;
    appliquer le deuxième ensemble de brasage sur l'au moins une rainure (103) dans le substrat (101) ; puis
    braser le deuxième ensemble de brasage au substrat.

11. Procédé de brasage, comprenant les étapes suivantes :

    se procurer un matériau de brasage (107) ;
    former au moins une rainure (103) dans le matériau de brasage (107) ;
    fixer des éléments de support (301) à l'intérieur de l'au moins une rainure (103) pour former un troisième ensemble de brasage ;
    se procurer un substrat (101) ;
    appliquer le troisième ensemble de brasage sur le substrat (101) ; et
    braser le troisième ensemble de brasage au substrat pour former un article brasé ;
    dans lequel la ou chacune des rainures (103) forme un microcanal de refroidissement dans l'article brasé.

12. Procédé de brasage de la revendication 11, dans lequel les éléments de support sont des céramiques.

13. Procédé de brasage de la revendication 11 ou la revendication 12, dans lequel les éléments de support sont des microtubes (311).

14. Procédé de brasage de la revendication 13, dans lequel le microtube (311) forme le microcanal dans l'article brasé.

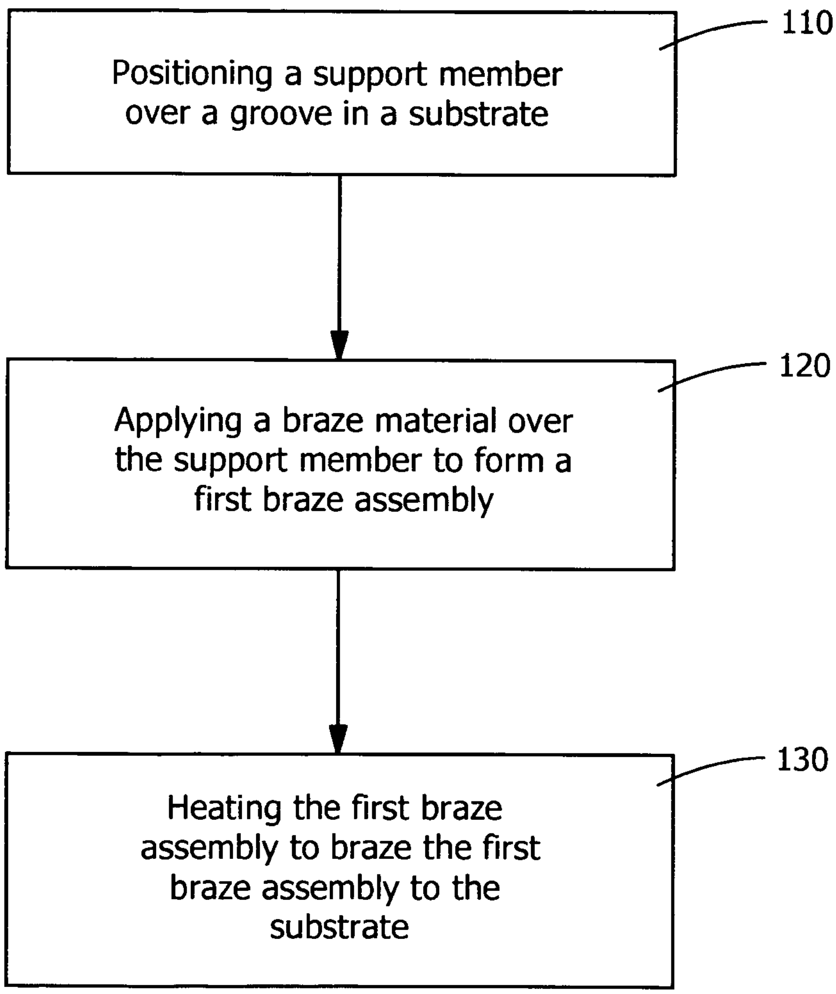

110
Positioning a support member over a groove in a substrate
120
Applying a braze material over the support member to form a first braze assembly
130
Heating the first braze assembly to braze the first braze assembly to the substrate

FIG. 1

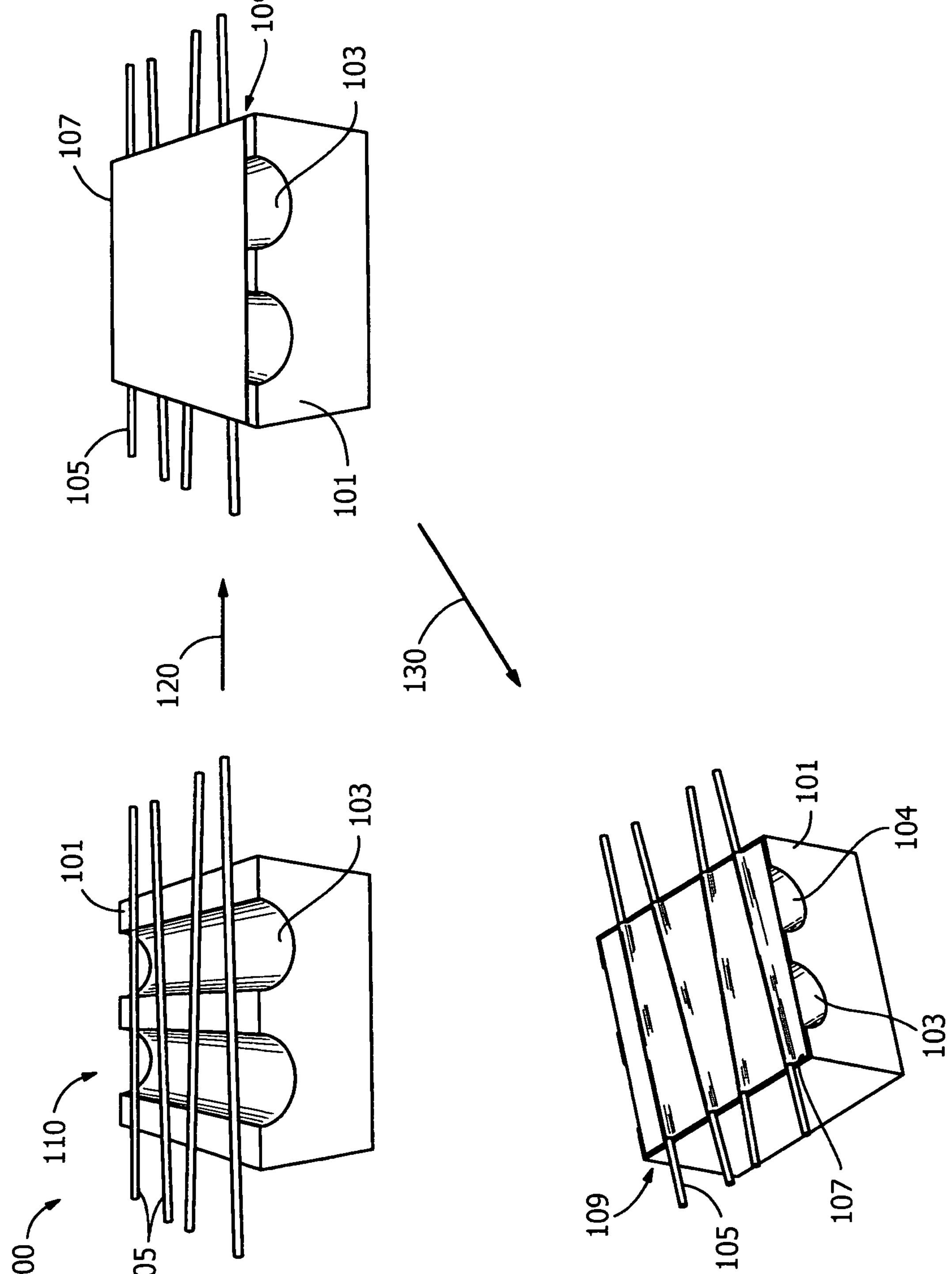

107
109
103
105
101
120
130
100
110
105
101
103
109
105
107
103
104
101

FIG. 2

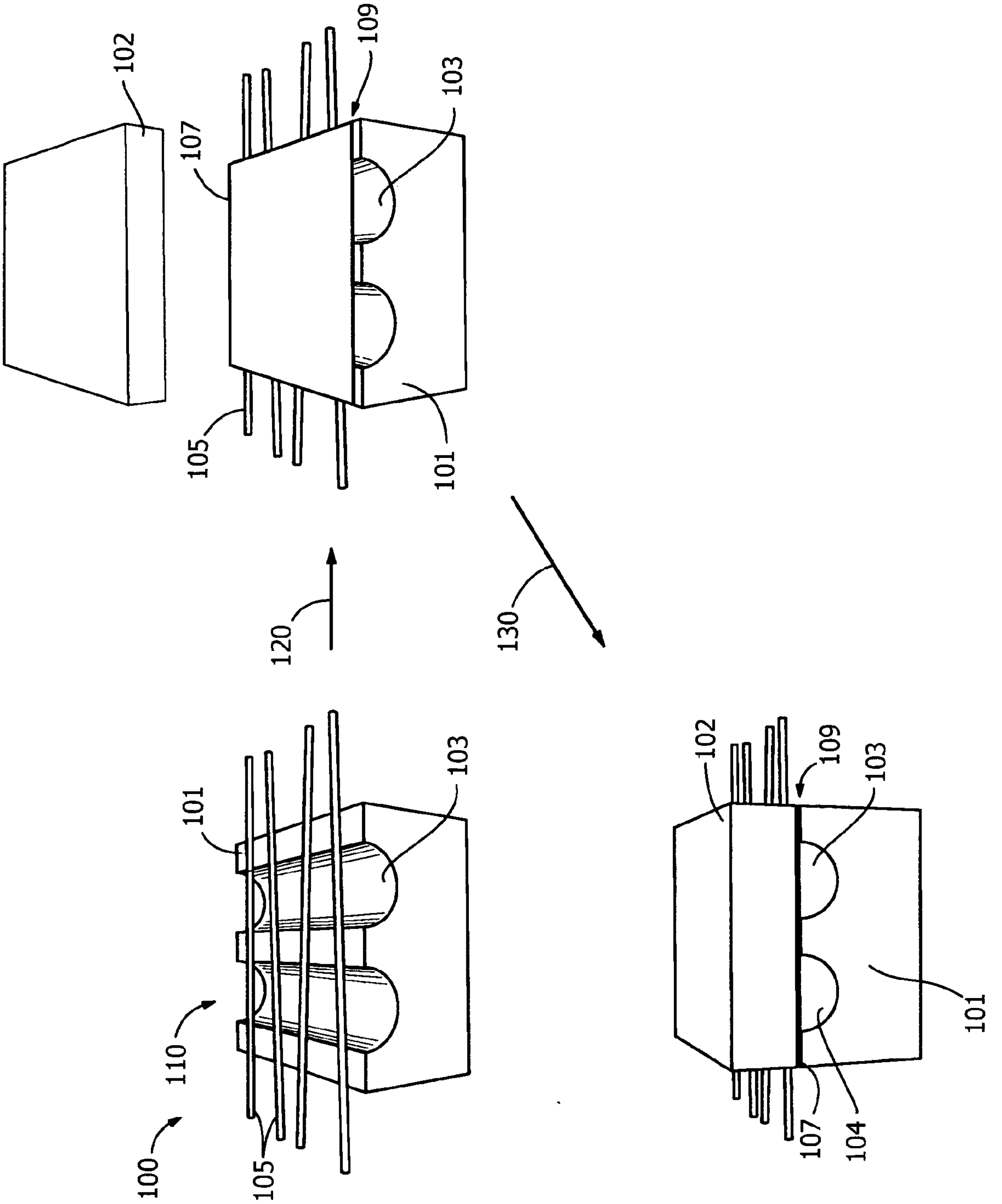

102
109
107
103
105
101
120
130
101
103
110
100
105
102
109
103
101
107
104

FIG. 3

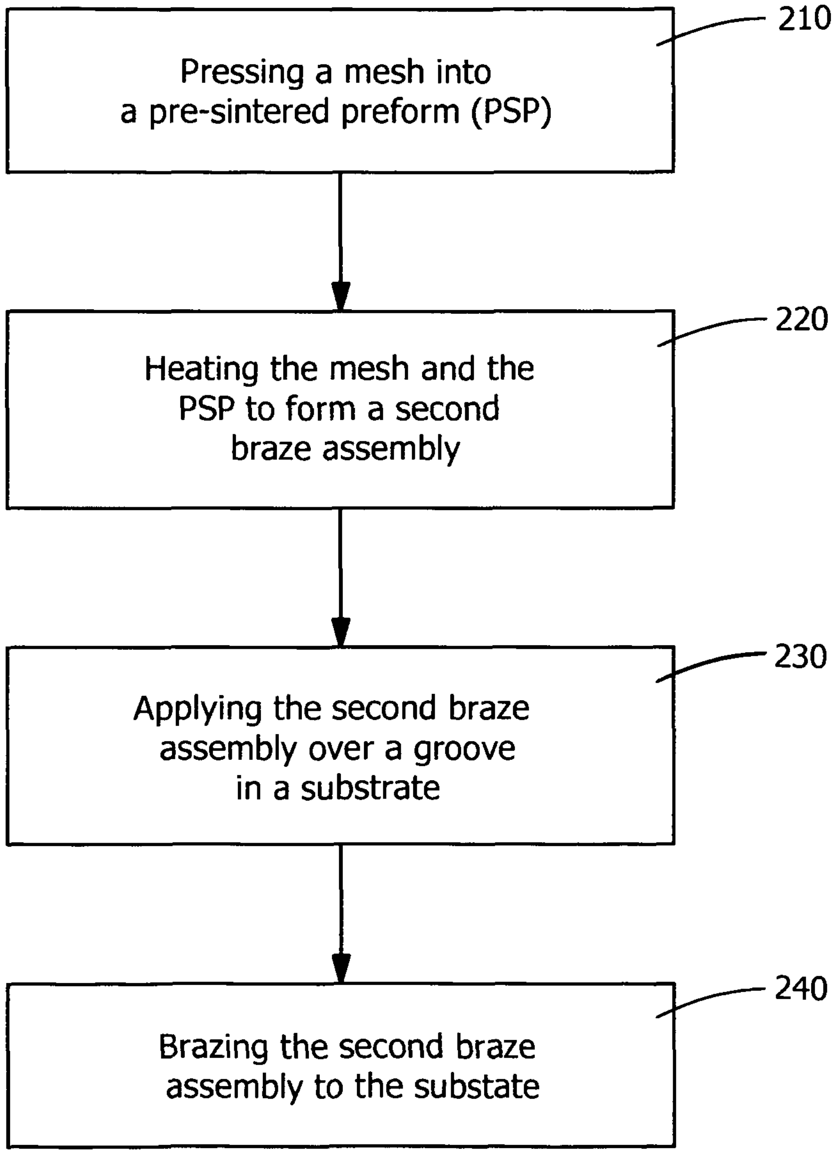

Pressing a mesh into
a pre-sintered preform (PSP)
210
Heating the mesh and the
PSP to form a second
braze assembly
220
Applying the second braze
assembly over a groove
in a substrate
230
Brazing the second braze
assembly to the substate
240

FIG. 4

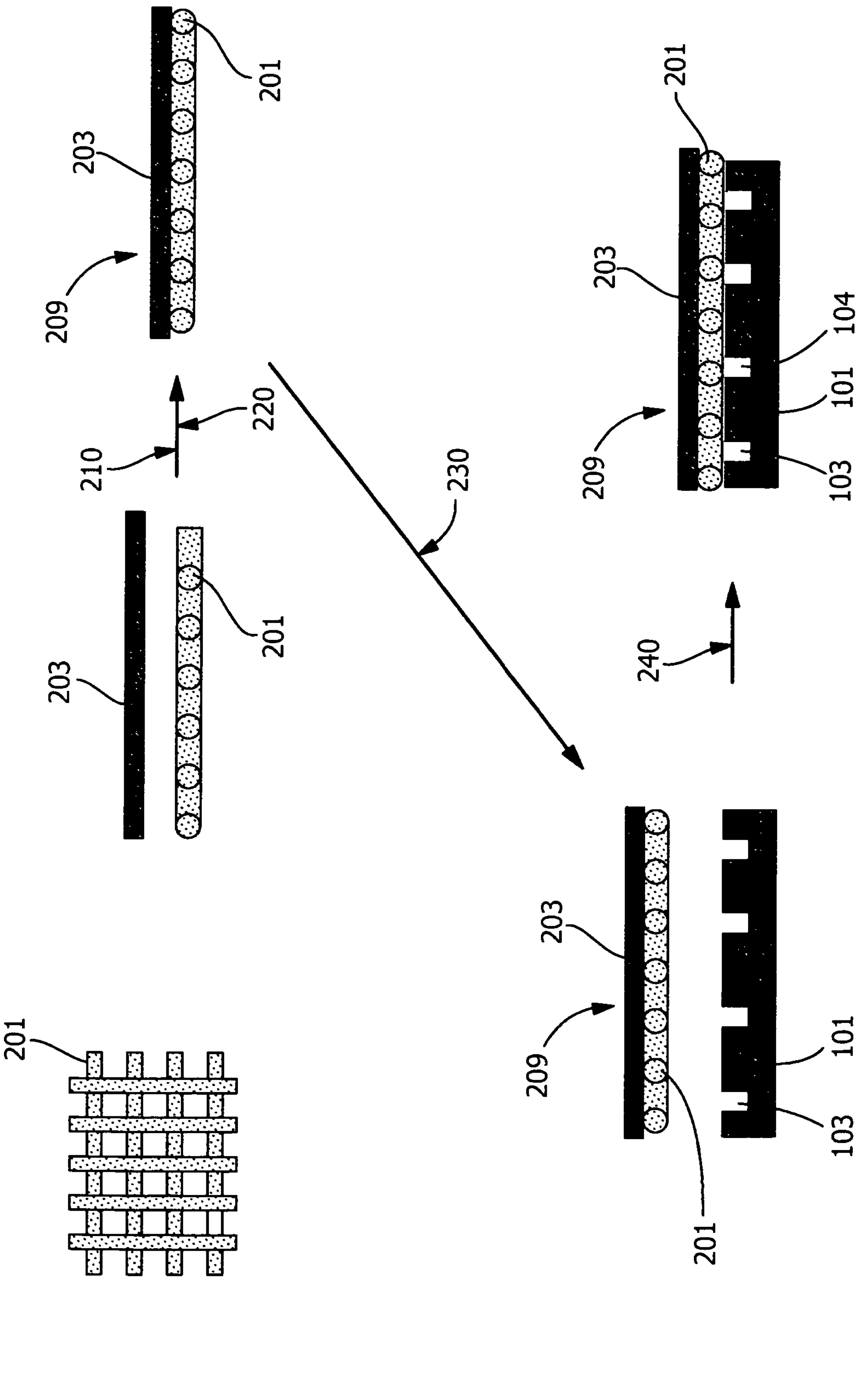


FIG. 5

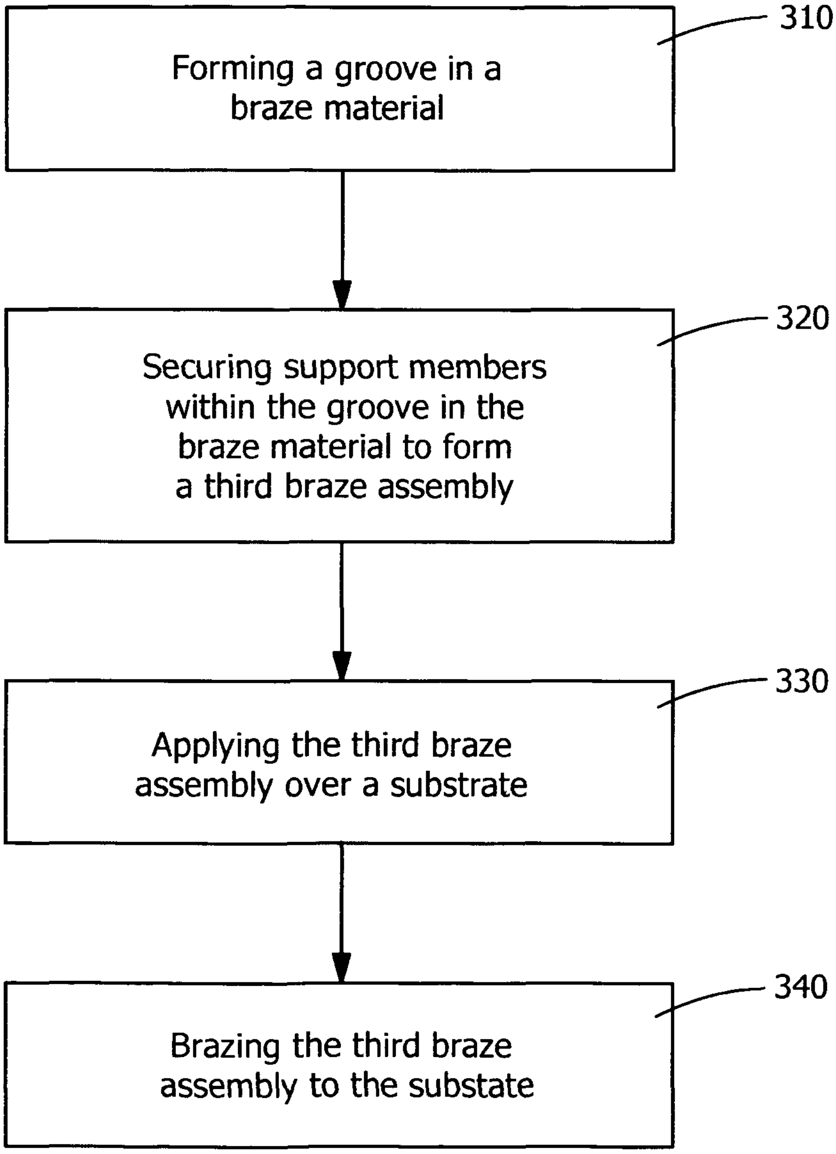

310
Forming a groove in a braze material
320
Securing support members within the groove in the braze material to form a third braze assembly
330
Applying the third braze assembly over a substrate
340
Brazing the third braze assembly to the substate

FIG. 6

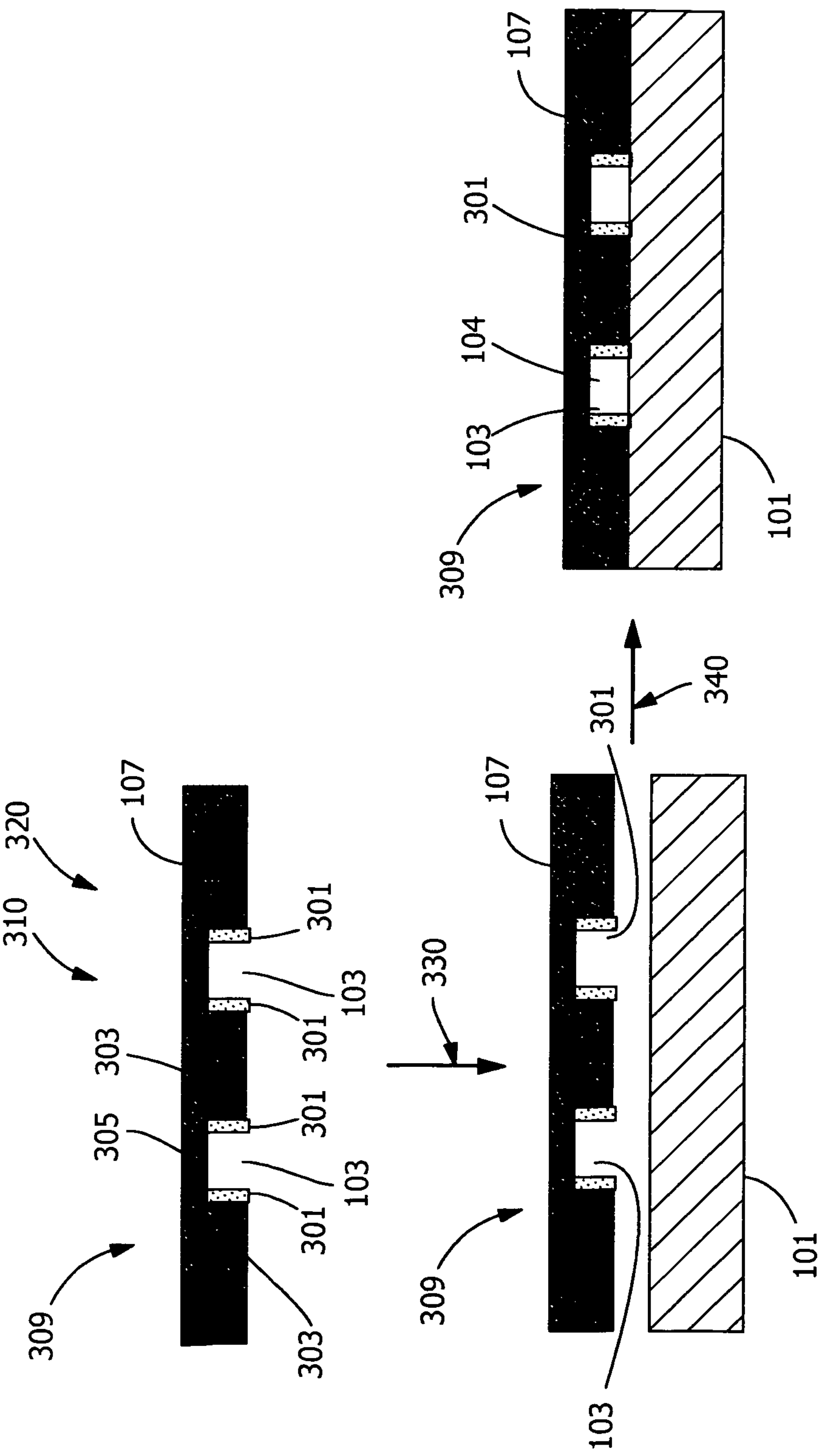

309
310
320
107
303
305
301
103
330
309
107
301
103
101
340
309
103
104
301
107
101

FIG. 7

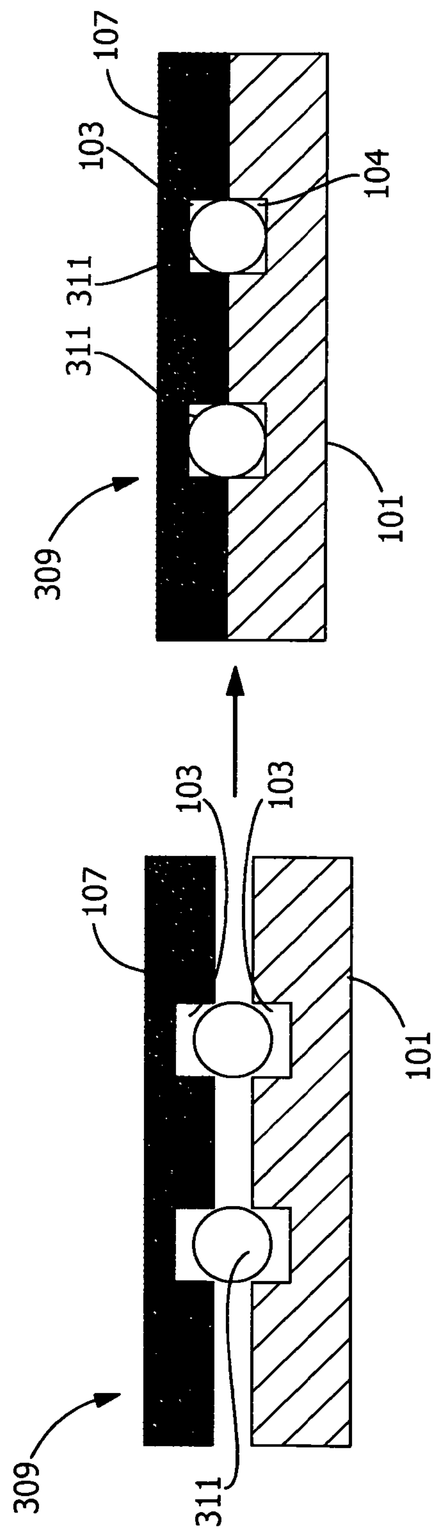
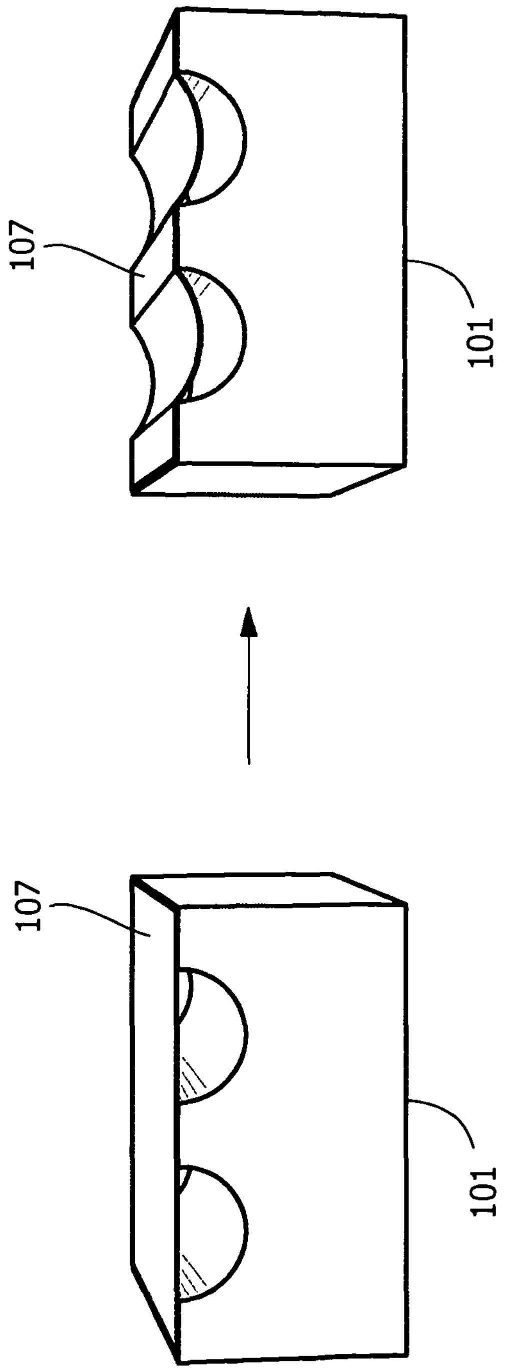


FIG. 8



PRIOR ART
FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010274311 A **[0002]**

KEMÉNYFORRASZTÓ ELJÁRÁS

SZTNH-100005508

SZABADALMI IGÉNYPONTOK

1. Keményforrasztó eljárás, amelynek során:

alapanyagot (101) alkalmazunk, amelynek legalább egy hornya (103) van;

támasztóelemet (105) alkalmazunk;

a támasztóelemet (105) az alapanyagban (101) lévő legalább egy horony (103) fölé állítjuk be;

keményforrasz anyagot (107) alkalmazunk, amelynek előalakított anyagában magas olvadáspontú ötvözet, alacsony olvadáspontú ötvözet, valamint kötőanyag van;

a keményforrasz anyagot (107) felhelyezzük a támasztóelemre (105), és a keményforrasz anyag, valamint a támasztóelem első keményforrasz egységet (109) képez; és

felhevítjük az első keményforrasz egységet (109) annak érdekében, hogy első keményforrasz egységet az alapanyaghoz (101) forrasszuk, ahol az első keményforrasz egység (109) felhevítésével az előalakított anyagot szintereljük, és az első keményforrasz egységet (109) az alapanyaghoz (101) forrasztjuk.

2. Az 1. igénypont szerinti keményforrasztó eljárás, amelynek során a keményforrasz anyagot (107) a legalább egy horony (103) fölött tartjuk anélkül, hogy a keményforrasz anyag bejutna a horonyba (103), és konvex határvonalat alakítana ki.

3. Az 1. vagy 2. igénypontok bármelyike szerinti keményforrasztó eljárás, amelynek során továbbá második alapanyagot (102) alkalmazunk; és

a második alapanyagot (102) a keményforrasz egység (109) fölötti helyzetbe állítjuk úgy, hogy az első keményforrasz egység (109) a legalább egy horonnyal (103) ellátott alapanyag (101), és a második alapanyag (102) közé kerül;

és ahol a hevítő lépés során összeforrasztjuk a második alapanyagot (102) a legalább egy horonnyal (103) ellátott alapanyaggal (101).

4. Az előző igénypontok bármelyike szerinti keményforrasztó eljárás, ahol a legalább egy horony (103) hűtő mikrocsatornát alkot az alapanyag (101) és a keményforrasz egység (109) közötti áramlás akadályozása nélkül.

5. Az előző igénypontok bármelyike szerinti keményforrasztó eljárás, ahol a keményforrasz anyag (107) nikkel alapú keményforrasz ötvözet.

6. Az előző igénypontok bármelyike szerinti keményforrasztó eljárás, ahol a keményforrasz anyag (107) hőtágulási együtthatója az alapanyag (101) hőtágulási együtthatójához hasonló.

7. Az előző igénypontok bármelyike szerinti keményforrasztó eljárás, ahol a támasztóelem (105) huzal vagy huzalháló.

8. Az előző igénypontok bármelyike szerinti keményforrasztó eljárás, amelynek során továbbá:

az előalakított anyagot támasztóelem (105) fölött helyezzük el annak érdekében, hogy kialakítsuk az első keményforrasz egységet (109).

9. Az előző igénypontok bármelyike szerinti keményforrasztó eljárás, ahol az alapanyag (101) nikkel vagy kobalt alapú ötvözet.

10. Az 1. igénypont szerinti keményforrasztó eljárás, amelynek során továbbá:

huzalhálót (201) alkalmazunk;

a huzalhálót rányomjuk az előalakított anyagra (203);

felhevítjük az előformát annak érdekében, hogy második keményforrasz egységet hozzunk létre;

továbbá második keményforrasz egységet helyezünk el az alapanyagban (101) lévő legalább egy horony (103) fölött); majd ezt követően

a második keményforrasz egységet az alapanyaghoz forrasztjuk.

11. Keményforrasztó eljárás, amelynek során:

keményforrasz anyagot (107) alkalmazunk;

legalább egy hornyot (103) képezünk ki a keményforrasz anyagban (107);

támasztóelemet (301) rögzítünk a legalább egy hornyon (103) belül annak érdekében, hogy harmadik keményforrasz egységet hozzunk létre;

alapanyagot (101) alkalmazunk;

a harmadik keményforrasz egységet az alapanyag (101) fölött rendezzük el; és

a harmadik keményforrasz egységet az alapanyaghoz forrasztjuk annak érdekében, hogy keményforrasztott terméket állítsunk elő;

ahol a legalább egy horony (103) hűtő mikrocsatornát képez a forrasztott termékben.

12. A 11. igénypont szerinti keményforrasztó eljárás, amelynek során a támasztóelemek kerámiák.

13. A 11. vagy 12. igénypontok szerinti keményforrasztó eljárás, ahol a támasztóelemek mikrocsövek (311).

14. A 13. igénypont szerinti keményforrasztó eljárás, ahol a keményforrasztott termékben a mikrocső (311) képezi a mikrocsatornát.