



- (51) **International Patent Classification:**
B23K 20/00 (2006.01) **B32B 15/01** (2006.01)
B23K 20/22 (2006.01)
- (21) **International Application Number:**
PCT/US2015/041857
- (22) **International Filing Date:**
23 July 2015 (23.07.2015)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
62/142,753 3 April 2015 (03.04.2015) US
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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).
- Published:**
— with international search report (Art. 21(3))

(54) **Title:** METHOD OF MAKING AN EDGE-TO-EDGE CLAD METAL COMPOSITE

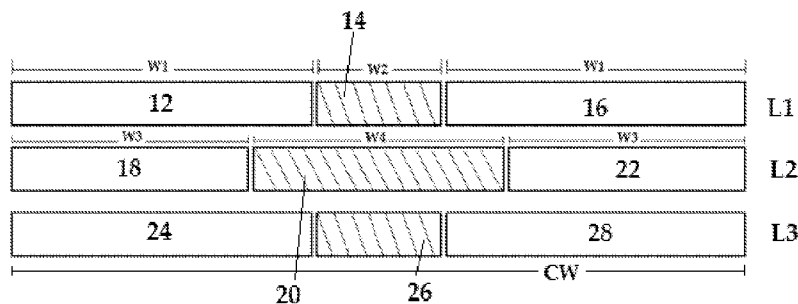


FIGURE 5A

(57) **Abstract:** A clad metal composite produced according to a method for edge-to-edge cladding of two or more different metals (such as aluminum and copper). The metals are joined next to each other to form an edge-to-edge or side-by-side clad bimetal. In one embodiment, nine metal strips are used to create the desired clad metal composite. The design includes strips of metal that have industry standard cut edges (such as, slit-cut edges). The clad metal composite may include multiple layers of metals positioned edge-to-edge.



METHOD OF MAKING AN EDGE-TO-EDGE CLAD METAL COMPOSITE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from Provisional Patent Application No. 62/142,753, filed on April 3, 2015, the disclosure of which is relied upon and incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to a metallic laminate composite having multiple layers clad in an edge-to-edge arrangement.

BACKGROUND OF THE INVENTION

[0003] Single metal products rarely exhibit all of the properties that are desired. As a result, it is often necessary to combine or clad metals together to achieve a product having the desired properties. Through the roll cladding of metals, it is possible to put disparate metals together in a process that opens the door for design of exciting new products. Cladding is generally provided by compressing metal strips together with heat and/or pressure, through the use of a roll cladding mill or a press. However, conventional cladding has limitations with respect to edge-to-edge cladding. These limitations are addressed in the process described herein.

SUMMARY OF THE INVENTION

[0004] A process for edge-to-edge cladding of two or more strips of different metals (such as aluminum and copper) is described herein. The metal strips are joined next to each other to form

an edge-to-edge or side-by-side clad bimetal. In one embodiment, nine metals strips are used to create the desired clad metal composite. The design includes strips of metal that have industry standard cut edges. The clad metal composite may include multiple layers of metals positioned edge-to-edge for cladding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figure 1 is a perspective view of a clad metal composite formed according to the edge-to-edge bimetal cladding process.

[0006] Figure 2 is a perspective view of individual strips of metal to form a clad metal composite using the edge-to-edge bimetal cladding process.

[0007] Figure 3 is an end view of the clad metal composite.

[0008] Figure 4 is a chart providing a summary of the theoretical copper-aluminum intermetallic compound thickness as a function of time and temperature.

[0009] Figure 5A is an end view of a basic bond configuration of nine layers of metals to be clad using the edge-to-edge bimetal cladding process.

[0010] Figure 5B is an end view of the combined layers of the bonded clad metal composite illustrated in Figure 5A, the combined layers being split into left and right slit-cuts.

[0011] Figure 6A is an end view of two single core layer clad metal composites, a top layer and a bottom layer as prepared to produce a dual-core bonded configuration.

[0012] Figure 6B is an end view of the clad metal composite having a double layer clad metal composite as shown in Figure 6A, being split into left and right slit-cuts.

[0013] Figure 7A is an end view of three single core layer clad metal composites, a top layer, a middle layer, and a bottom layer as prepared to produce a triple-core bonded configuration.

[0014] Figure 7B is an end view of the bonded clad metal composite having a triple layer clad metal composite as showing in Figure 7A, being split into left and right slit-cuts.

[0015] Figure 8A is an end view of a basic bond configuration of nine layers of metals to be clad using the edge-to-edge bimetal cladding process as shown in Figure 5A, with two additional metal strengtheners added as additional layers.

[0016] Figure 8B is an end view of the combined layers of the bonded clad metal composite illustrated in Figure 8A.

[0017] Figure 9A is an end view of a double layer clad metal composite having a dual-core, with a top layer, a bottom layer, and a metal strengthener positioned between the top layer and bottom layer as prepared for bonding.

[0018] Figure 9B is an end view of the bonded clad metal composite having a double layer clad metal composite with a metal strengthener as showing in Figure 9A.

[0019] Figure 10A is an end view of a triple layer clad metal composite having a triple-core, with a top layer, a middle layer, and a bottom layer, and a first metal strengthener between the top and middle layers and a second metal strengthener between the middle and bottom layers as prepared for bonding.

[0020] Figure 10B is an end view of the bonded clad metal composite having a triple layer clad metal composite with metal strengthener layers as showing in Figure 10A.

[0021] Figure 11A is an end view of a clad metal composite of five layers of metals to be clad using the edge-to-edge bimetal cladding process.

[0022] Figure 11B is an end view of the combined layers of the clad metal composite illustrated in Figure 11A.

[0023] Figure 11C is an end view of the bonded clad metal composite as illustrated in Figures 11A and 11B.

[0024] Figure 12A is an end view of an inlay clad metal composite of four layers of metals to be clad using the edge-to-edge bimetal cladding process.

[0025] Figures 12B is an end view of the combined layers of the bonded clad metal composite illustrated in Figure 12A.

[0026] Figures 12C is an end view of the combined layers of the bonded clad metal composite illustrated in Figure 12A, the combined layers being split into left and right cuts.

[0027] Figures 13A and 13B are end views of an inlay clad metal composite of seven layers of metals to be clad using the edge-to-edge bimetal cladding process.

[0028] Figure 13C is an end view of the combined layers of the bonded clad metal composite illustrated in Figure 13A.

[0029] Figure 13D is an end view of the combined layers of the clad metal composite illustrated in Figure 13A, the combined layers being split into left and right slit-cuts.

[0030] Figures 14A, 14B, 14C and 14D illustrate an embodiment of the clad material that includes four metal layers.

[0031] Figure 15 is a process flow chart illustrating the process steps for bonding the metal strips made from a first metal and a second metal.

[0032] Figure 16 is an illustration of the layers of metals being clad using two rollers.

[0033] Figure 17 is a diagram of a bonding mill assembly used to clad nine layers of a metal into a single clad metal composite.

[0034] Figure 18 is a photomicrograph of the double core copper-aluminum at the transition from copper to aluminum.

DETAILED DESCRIPTION OF THE INVENTION

[0035] A new process for edge-to-edge cladding of metals is described herein. Essentially, two or more different metals (such as aluminum and copper, although other combinations may be used) are joined next to each other to form an edge-to-edge or side-by-side clad bimetal **10** (see Figures 1 – 3).

[0036] Looking at Figures 2, 5A, and 5B, nine strips of metals are used to create the desired clad metal composite **10**. The strips of metal have non-profiled, substantially straight strip edges, such as industry standard slit edges. In the embodiment described herein, the strips of metal are made of copper and aluminum; however, a variety of metal combinations may be implemented to provide the clad metal composite **10**. For example, the combination could include a first metal of the following metals including, but not limited to, aluminum, nickel, steel and/or stainless steel joined with copper, steel and/or stainless steel joined with aluminum, or other multiple metal combinations.

[0037] Referring to Figures 5A and 5B, the clad metal composite **10** of a first embodiment includes three layers **L1**, **L2**, **L3**, with each layer **L1**, **L2**, **L3** having three strips of metal. That is, the first layer **L1** includes first and second side strips **12**, **16** positioned on opposite sides of first center strip **14**, the second layer **L2** includes third and fourth side strips **18**, **22** positioned on opposite sides of second center strip **20**, and the third layer **L3** includes fifth and sixth side strips **24**, **28** positioned on opposite sides of third center strip **26**. In the illustrated embodiment, each layer **L1**, **L2**, **L3** has two side strips of a first metal (such as solid aluminum) and one strip of a second metal (such as copper). The side strips of the first metal are labeled **12**, **16**, **18**, **22**, **24** and **28**, and the center strips of the second metal are labeled **14**, **20**, **26**. In this embodiment, each individual strip of the second metal (e.g., copper) is centrally positioned between two strips of

the first metal (e.g., aluminum), with the side strips abutting the center strip. The side strips of the first metal are clad or bonded alongside the center strips of the second metal. However, it is foreseen that the composition of the metal strips could be reversed. That is, each layer could include two strips of copper on two sides of a strip of aluminum.

[0038] Continuing to view Figure 5A, each layer **L1**, **L2**, **L3** substantially has a composite width **CW**. Referring to the first layer **L1**, the width **W2** of the center strip **14** is substantially the same as the width of the center strip **26** in the third layer **L3**. In comparison, the width **W4** of the center interlayer strip **20** in the second or middle layer **L2** is substantially greater than the width **W2** of the center strips **14**, **26** in the first and third layers **L1**, **L3**. Likewise, the width **W1** of the first and second side strips **12**, **16** is substantially commensurate with the width of the fifth and sixth side strips **24**, **28**, while the width **W3** of the third and fourth side strips **18**, **22** in the second layer **L2** is less than the width **W1** of the side strips **12**, **16**, **24**, **28** in the first and third layers **L1**, **L3**. The differences in the width **W4** of the center interlayer strip **20** and the width **W2** of the upper and lower center strips **14** and **26** will result in an “overlapping” stepped clad bond zone in the central region of the clad metal composite **10**. This metal strip width overlap can be controlled to vary bond zone region as may be required for custom applications. Figures 5A and 5B show the center interlayer strip **20** touching each of the eight other strips **12**, **14**, **16**, **18**, **22**, **24**, **26**, **28**, with the aluminum surrounding sides of the center interlayer strip **20** and copper strips **14** and **26** adjacent the top and bottom of the center interlayer strip **20** as the metals to be clad enter the bonding mill **299**. The present clad metal composite utilizes a “stepped” or staggered inner layer(s) to provide the basis of the bonded joint configuration of the clad metal composite **10**.

[0039] The metal strips **12 – 28** can be bonded utilizing heated or non-heated bonding mill rolls **300, 302, 304, 306** in a bonding mill **299**. Multiple core layer configurations can be produced with or without intermediate heat treatment. Avoiding intermediate heat treatments can be beneficial by minimizing the formation of possibly harmful copper-aluminum intermetallics as described herein. Clad metal composite properties of the bonded composite **10** can be optimized during the heat treatment cycle. Heat treatment cycle can be achieved by batch or continuous heat treatment.

[0040] Figure 4 is a chart that provides a summary of the theoretical copper-aluminum intermetallic compound (IMC) thickness comparison between the expected temperature and time cycles for both a Batch Sinter Heat Treatment and a Strand Sinter Heat Treatment. The expected IMC growth for the 450°F/4 Hr Batch Sinter is ~1.52 microns. The expected IMC Growth for the 750°F/3 Min Strand Sinter is ~3.09 microns. Therefore, the batch sinter process is preferred in the present design, and is expected to result in essentially half the IMC thickness of the Strand Sinter process. The importance of this IMC Growth is the negative effect it has on bond strength, formability, thermal and electrical conductivity. Increased IMC thickness reduces bond strength, formability, thermal and electrical conductivity.

[0041] Figures 5A and 5B illustrate one exemplary embodiment of the clad metal composite **10**. While not limited to the illustrated configuration, this embodiment shows nine independent copper and aluminum strips bonded as one single clad metal composite **10**. That is, the single clad assembly **10** includes three top strips, three middle strips, and three bottom strips. Other embodiments are described herein.

[0042] Looking to Figures 5B, 6B, 7B, 9B, 10B, 13C, 14D, 15D, and 16D, the bonded clad metal composite **10** can be slit to produce a left and right strip profiles that could then be stamped into the formed stamp parts, as depicted in Figure 1.

[0043] The process for bonding the various strips into a clad metal composite **10** is illustrated in Figure 15. Initially, the metals to be used in the clad metal composite **10** are selected in steps **200, 202, 204**. In the illustrated embodiment, there are metal strips in each layer that are comprise aluminum and copper (as well as other potential embodiments). The design includes strips of metal that have industry standard cut edges. The various metal strips are prepared for bonding via cleaning in steps **206, 208, 210**. Cleaning dirt and oils from the strip surface is necessary to ensure clad bond integrity. In the present embodiment, cleaning is performed to ensure the surface of each strip is properly prepared for clad bonding.

[0044] Once the metals are prepared, the multiple metal strips are aligned (step **212**) so that the industry standard cut edges in each layer **L1, L2, L3** are positioned as desired. In the nine-strip embodiment shown in Figures 5A and 5B, each of the respective three layers **L1, L2, L3** are aligned according to the desired embodiment and application. Referring to Figure 5A, metal strips **12, 14, 16** in the top layer **L1** are aligned so that the central metal strip **14** abuts strips **12, 16**; metal strips **18, 20, 22** in the middle layer **L2** are aligned so that the central metal strip **20** abuts strips **18, 22**, and metal strips **24, 26, 28** in the bottom layer **L3** are aligned so that the central metal strip **26** abuts strips **24, 28**. The metal strips are aligned in each layer **L1, L2, L3**, and each layer **L1, L2, L3** is aligned with respect to the other layers **L1, L2, L3** to achieve the desired overlapping step clad metal composite.

[0045] The alignment of the metal strips may be performed using custom guides that are known in the art and not specifically illustrated in the attached figures. These guides align the

various individual metal strip widths simultaneously as they are drawn into the bonding mill rolls **300, 302, 304, 306**. For example, Figure 16 provides a schematic illustrating nine various individual metal strip widths **12 – 28** simultaneously being drawn into the rolls **300, 302, 304, 306** of the bonding mill **299**. However, the number of layers and strips may be varied according to the desired use by the producer.

[0046] The next step is the roll bond (step **214**). This is the process step where the individual metal strips are “clad” into one piece comprising a portion made of the first metal **6** and a portion made of the second metal **8**. Looking to Figure 17, this step is performed on a roll cladding mill **299** specifically design and built to withstand the separating force and heat generated during the heavy metal thickness reduction.

[0047] The bonded layers **L1, L2, L3** may then treated through sintering (step **216**). Sintering is a heat treatment step which promotes the metallurgical bond between the clad layers. This heating process can be done using a continuous strand annealing furnace or a batch annealing furnace. The bonded layers may be processed using either option, and the processing option is selected according to the best method known in the art based on the metal requirements and final mechanical properties as specified by the end user.

[0048] For the copper-aluminum metal system the formation of “intermetallic” compounds can be detrimental to the bond integrity (bond strength), formability, thermal and electrical conductivity. Figure 4 includes a graph that provides a theoretical comparison of the calculated copper-aluminum intermetallic (IMC) thickness values as a function of time and temperature.

[0049] The producer will determine best manufacturing practices to meet final customer specifications. The clad metal composite **10** is then slit (step **218**) and readied for inspection and shipment (step **220**).

[0050] Furthermore, one set of bonded metal strips of the clad metal composite **10** may be combined with a separate clad metal composite **10**, with the resulting clad metal composite **30** having additional clad composite layers **CL1**, **CL2**. Such an embodiment is illustrated in Figures 6B and 7B. In Figures 6A and 6B, a clad metal composite **30** having a double core layer bond configuration is shown. In this embodiment, two independent sets or composite layers **CL1**, **CL2** of bonded strips **10** are combined to achieve a clad metal composite **30** having a desired thickness with two copper core extensions. That is, once each set of clad metal composite **10** has been bonded as described above, the two sets will then be aligned and roll clad together to produce the clad metal composite **30**. A photomicrograph of the double core copper-aluminum at the transition from copper to aluminum is provided in Figure 18, and this photograph illustrates the stair step configuration. Referring to Figure 6B, the clad metal composite **30** may then be slit into two clad halves **30A** and **30B**.

[0051] Figures 7A and 7B illustrate a triple layer bond configuration, with three layers **CL1**, **CL2**, **CL3** of multilayer bonded strips **10**. The process to prepare a triple layer bond is to first form three independent sets of multilayer bonded strips **10**, align each of the sets with each other, and then roll clad the three sets of bonded strips **10** to achieve the desired triple core layer clad material **40**. The clad material **40** may then be slit into two clad material halves **40A** and **40B**.

[0052] Looking to Figures 8A and 8B, an additional embodiment is illustrated. In this embodiment, the set of bonded layers **L1**, **L2**, **L3** illustrated in Figure 5A additionally includes one or more supplemental metal strengthener layers **50**, **52** positioned between the multi-metal strip layer **L1**, **L2**, **L3** and bonded to for the clad metal composite **54**. The sets of bonded metal strips are prepared as described above, simply with the additional supplemental metal strengthener layers **50**, **52** positioned in between the layers **L1**, **L2**, **L3**. That is, one strengthener

layer **50** may be positioned between the first layer **L1** and the second layer **L2**, and a second strengthener layer **52** may be positioned between the second layer **L2** and the third layer **L3**. As an example, the additional metal strengthener layer **50, 52** can be from the group of nickel, aluminum, copper, steel, stainless steel or other similar material in the copper-aluminum configuration. The metal strengthener layer **50, 52** will increase the bulk metal strength and alter the thermal and electrical resistivity of the clad metals **54**.

[0053] Looking to Figures 9A and 9B, an additional embodiment of the invention is illustrated in which a supplemental strengthener layer **60** of an additional metal is positioned between two clad metal composites **10** having composite layers **CL1, CL2**. In this embodiment, each clad metal composite **10** is prepared as described above and are prepared to be bonded together to create a double core layer bond clad composite **30**, but an additional metal strengthener layer **60** is positioned between the clad metal composites **10**. The clad metal composites **10** and strengthener layer **60** are roll bonded to achieve a strengthened double core layer bond clad composite **62**. The clad material **62** may then be slit into two clad metal composite halves **62A** and **62B** (see Figure 9B).

[0054] Figures 10A and 10B illustrate a similar embodiment to the one illustrated in Figures 9A and 9B, with this embodiment including three layers **CL1, CL2, CL3** of bonded core layers **10** that are combined together with two additional metal layers **70, 72** positioned between each set of bonded metal strips **10**. The sets **10** are bonded together to create a triple core layer bond clad metal composite **74**, but the additional metal layer **72** is positioned between the sets that are roll bonded to achieve a desired result. The clad material **74** may then be slit into two clad metal composite halves **74A** and **74B**.

[0055] Finally, looking to Figures 12A – 14D, additional embodiments of independent sets of bonded layers prepared according to the steps described above. These embodiments illustrate that other combinations of layer configurations may be prepared in addition to the three layers of three strips of metals as described above. The common element to each design is that there is a stair step arrangement of strips of differing metals that are positioned in an edge-to-edge arrangement.

[0056] Figure 11A, 11B and 11C illustrate an embodiment that includes three metal layers: a base layer **L3**, a primary layer **L2**, and a top layer **L1**. However, in this embodiment, the top layer **L1** and the base layer **L3** have single metal strips **90**, **94**, respectively, of aluminum. The metal strips **92**, **94**, **96** in the middle metal layer include a single metal strip of copper **94** with metal strips **92**, **96** of aluminum on both sides of the copper strip **94**. As a result, there is a single layer **94** of copper in the center of the clad material **100**, with the stair step configuration, as shown in Figure 11C. When bonded, the aluminum layers combine into a single layer **6** with the independent copper layer **94** in a locked connection in the layer **6**.

[0057] Figures 12A and 12B illustrate embodiments related to the one shown in Figures 11A, 11B, and 11C, with the top aluminum layer shown in Figures 11A, 11B, 11C removed from the bonded set of layers to achieve the clad metal composite **116**. Therefore, there is a base layer **116** of aluminum with the top layer having three metal strips – a center strip **112** of copper positioned between two side strips **110**, **114** of aluminum. This embodiment is further shown in Figure 12C with a central cut to create two split strips of bonded metals **116**.

[0058] Figures 12A, 12B and 12C illustrate the two layer embodiment. The base layer **L2** is a single metal strip **115** of aluminum. A primary or top layer **L1** positioned on the base layer **L2** includes a copper strip **112** with aluminum strips **110**, **114** of aluminum edge to edge to both

sides of the copper strip **112**. The combined width of the three metal strips **110, 112, 114** in top layer **L1** is substantially equivalent to the width of the base layer **L2**. The strips **110, 112, 114, 115** are bonded together to create the clad metal composite **116** comprising the first metal **6** cradling the second metal **112**. The clad metal composite **116** may then be slit into two clad metal composite halves **116A** and **116B**.

[0059] Figures 13A, 13B, 13C and 13D illustrate an embodiment that includes three metal layers **L1, L2, L3**. However, in this embodiment, the top layer **L1** has two metal strips **140, 144** of a first metal (e.g., aluminum) and a central metal strip **142** of a second metal (e.g., copper) and the base layer **L3** has a single metal strip **152** of the first metal. The metal strips **146, 148, 150** in the center metal layer **L2** include a single metal strip **148** of the second metal with metal strips **146, 150** of the second metal on both sides of the central metal strip **148**. As a result, there is a double layer of the second metal (e.g., copper) in the center of the clad metal composite **154**. When the layers **L1, L2, L3** are bonded, a core metal strip **8** is formed as an inlay with a stair step configuration. This embodiment is further shown in Figure 13D with a central slit-cut to create two split strips of bonded clad metal composites **154A, 154B**.

[0060] Figures 14A, 14B, 14C and 14D illustrate an embodiment that includes four metal layers **L1, L2, L3, L4**. In this embodiment, the first layer **L1**, second layer **L2** and third layer **L3** are the same as the clad metal composite **10** illustrated in Figures 5A and 5B. The layers **L1, L2, L3** all have two aluminum metal strips and a central copper metal strip and the base layer has a single metal strip of aluminum as illustrated in Figure 5A. The metal strips in the first, second and third metal layers **L1, L2, L3** include a single central metal strip **14, 20, 26** of copper with metal strips of aluminum on both sides. However, the copper metal strip in the second layer is wider than the copper metal strip in the first and third metal layers. The three layers **L1, L2, L3**

are bonded so that there is a triple layer of copper in the center of the clad metal composite **10**. Once bonded, the fourth layer **L4** of a supplemental base metal strip **160** is added, wherein the supplemental base metal strip **160** is a single metal strip of aluminum. This fourth layer **L4** is then bonded with the clad metal composite **10** to produce a bonded clad metal composite **162** having three layer core copper metal strip as an inlay with a stair step configuration. This embodiment is further shown in Figure 14D with a central slit-cut to create two split strips of the clad metal composite **162A**, **162B**.

[0061] Having thus described exemplary embodiments of a method to produce metallic composite metal, it should be noted by those skilled in the art that the within disclosures are exemplary only and that various other alternatives, adaptations, and modifications may be made within the scope of this disclosure. Accordingly, the invention is not limited to the specific embodiments as illustrated herein, but is only limited by the following claims.

CLAIMS

What is claimed is:

1. A method for creating a clad metal composite strip comprising the steps of:

a) providing a first layer of metal strips including a first side strip of a first metal, a second side strip of the first metal and a center strip of a second metal, the first side strip abutting one edge of the center strip and the second side strip abutting the opposite edge of the first center strip, wherein the first center strip has a first width and the first and second side strips having a second width;

b) aligning a second layer of metal strips with the first layer of metal strips, the second layer of metal strips having a width commensurate with the width of the first layer of metal strips and including a second center strip of the second metal and a third and fourth side strips of the first metal, the third side strip abutting one edge of the second center strip and the fourth side strip abutting the opposite edge of the second center strip, wherein the second center strip has a third width and the third and fourth side strips have a fourth width;

c) aligning a third layer of metal strips with the second layer of metal strips, the third layer of metal strips having a width commensurate with the width of the first and second layers of metal strips and including a third center strip of the second metal and a fifth and sixth side strips of the first metal, the fifth side strip abutting one edge of the third center strip and the sixth side strip abutting the opposite edge of the third center strip, wherein the width of the third center strip is commensurate with the first width and the width of the fifth and sixth side strips is commensurate with the second width, wherein the second width of the second center strip varies from the first width of the first and third center strips; and

- d) bonding the layers of metal strips together into a first clad metal composite.
2. The method as described in claim 1 further comprising the steps of:
- aligning a fourth layer of a metal strip with the bonded metal strip, the fourth layer having a width commensurate with the width of the first clad metal composite and comprising the second metal; and
- bonding the fourth layer with the bonded metal strip.
3. The method as described in claim 1, wherein the first metal is aluminum and the second metal is copper.
4. The method as described in claim 1, wherein the first metal is selected from the group consisting of aluminum, steel, stainless steel, and nickel, and the second metal is selected from the group consisting of copper and aluminum, the first metal being unique to the second metal.
5. The method as described in claim 1, wherein the first metal is selected from the group consisting of steel and stainless steel, and the second metal is selected from the group consisting of aluminum and nickel.
6. The method as described in claim 1 wherein, prior to step d), further comprising the step of adding a metal strengthener layer between the first layer and the second layer and/or between the second and third layer.
7. The method as described in claim 6 wherein the metal strengthener layer is selected from the group consisting of nickel, aluminum, steel, stainless steel, and copper.
8. The method as described in claim 1 further comprising the step of sintering the layers of the bonded metal strips after bonding.
9. The method as described in claim 1 further comprising the step of:
- repeating steps a) through d) to prepare a second clad metal composite;

bonding the first clad metal composite with the second clad metal composite to form a double core layer clad metal composite.

10. The method as described in claim 9 wherein, prior to bonding the first clad metal composite with the second clad metal composite, performing the steps of:

positioning a metal strengthener between the first clad metal composite and the second clad metal composite; and

bonding the first clad metal composite, the metal strengthener, and the second clad metal composite to form a strengthened double core layer bond clad metal composite.

11. The method as described in claim 9 further comprising the steps of:

repeating steps a) through d) of claim 1 to prepare a third clad metal composite;

bonding the first bonded metal composite, the second clad metal composite, and the third clad metal composite to form a triple core layer bond clad metal composite.

12. The method as described in claim 11 wherein, prior to bonding the first clad metal composite, the second clad metal composite, and the third clad metal composite, performing the steps of:

positioning a first metal strengthener between the first clad metal composite and the second clad metal composite;

positioning a second metal strengthener between the second clad metal composite and the third clad metal composite; and

bonding the first clad metal composite, the first metal strengthener, the second clad metal composite, the second metal strengthener, and the third clad metal composite to form a strengthened triple core layer bond clad metal composite.

13. A method of creating a clad metal composite with an inlay laminate construction comprising the steps of:

- a) providing a base layer having at least one metal strip of the first metal, the base layer having a composite width;
- b) providing a primary layer comprising two side strips of a first metal and a center metal strip of a second metal, the center strip positioned between the two side strips, the primary layer of metal strips having a width substantially equivalent to the composite width;
- c) aligning the primary layer of metal strips with the base layer of at least one metal strips; and
- d) bonding the primary and base layers of metal strips to form a clad metal composite with an inlay laminate construction.

14. The method as described in claim 13 wherein, prior to step d), including the steps of:

- providing a top layer comprising a metal strip of the first metal, the top layer of metal strip having a composite width; and
- bonding the top, primary and base layers to form a clad metal composite with a center core laminate construction.

15. The method as described in claim 13 wherein, prior to step d), including the steps of:

- providing a top layer comprising two top side strips of the first metal and a top center metal strip of the second metal, the top center strip positioned between the two top side strips, the top layer of metal strips having a composite width; and
- bonding the top, primary and base layers to form a clad metal composite with a inlay laminate construction.

16. The method as described in claim 15 wherein the width of the top center metal strip varies from the width of the center metal strip of the primary layer to form a clad metal composite with a stepped inlay laminate construction.

17. The method as described in claim 15 wherein step a) comprises:

providing a base layer comprising two side strips of a first metal and a center metal strip of a second metal, the center strip positioned between the two side strips, the base layer of metal strips having the composite width.

18. The method as described in claim 17 wherein the width of the base center metal strip varies from the width of the center metal strip of the primary layer.

19. The method as described in claim 18 further comprising the steps of:

aligning a fourth layer of a supplemental base metal strip with the base layer, the fourth layer having a width commensurate with the composite width and comprising the first metal; and bonding the fourth layer with the bonded metal strip.

20. The method as described in claim 17 further comprising the steps of:

producing a first clad metal composite;
repeating the steps to prepare a second clad metal composite; and
bonding the first clad metal composite with the second clad metal composite.

21. The method as described in claim 20, wherein prior to bonding the first clad metal composite with the second clad metal composite, including the step of:

adding a strengthener between the first clad metal composite with the second clad metal composite.

22. The method as described in claim 21 further comprising the steps of:

repeating the steps of claim 17 to prepare a third clad metal composite; and

bonding the first clad metal composite, the second clad metal composite, and the third metal composite.

23. The method as described in claim 22, wherein prior to bonding the first clad metal the second clad metal composite, and the third clad metal composite, including the steps of:

adding a first metal strengthener between the first clad metal composite with the second clad metal composite; and

adding a second metal strengthener between the second clad metal composite and the third clad metal composite.

24. The method as described in claim 13, wherein the first metal is selected from the group consisting of aluminum, steel, nickel and stainless steel, and the second metal is selected from the group consisting of copper and aluminum, the first metal being unique to the second metal.

25. The method as described in claim 13, wherein the first metal is selected from the group consisting of steel and stainless steel, and the second metal is selected from the group consisting of aluminum and nickel.

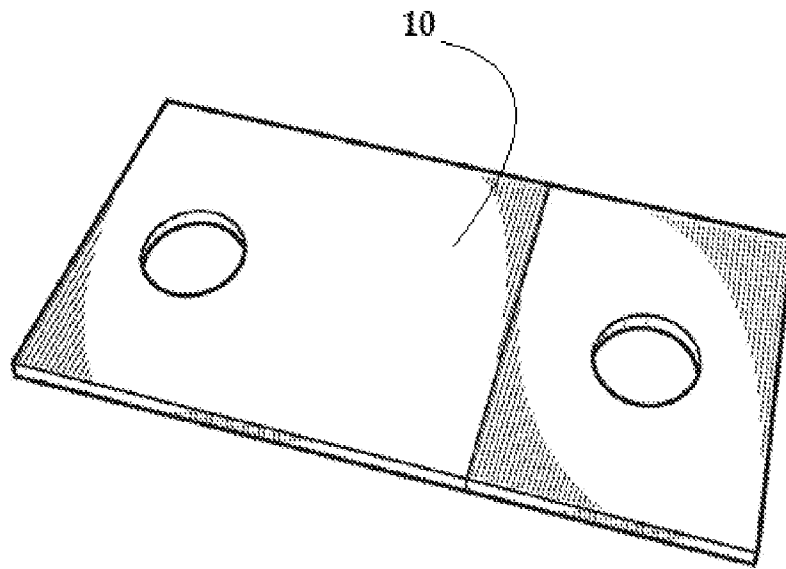


FIGURE 1

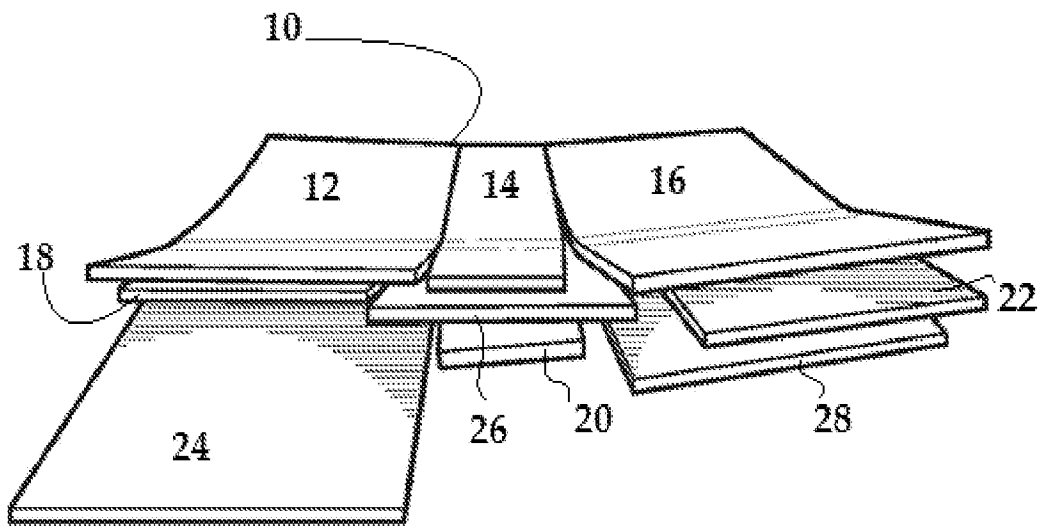


FIGURE 2

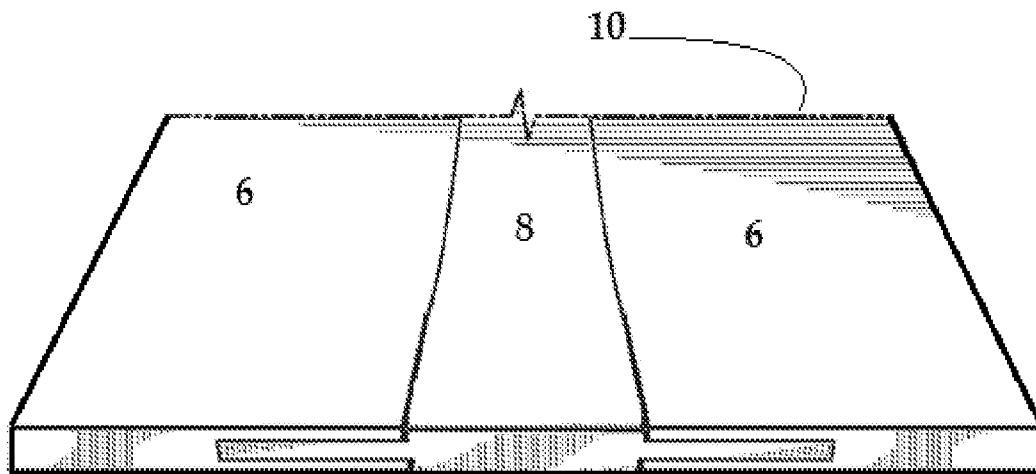


FIGURE 3

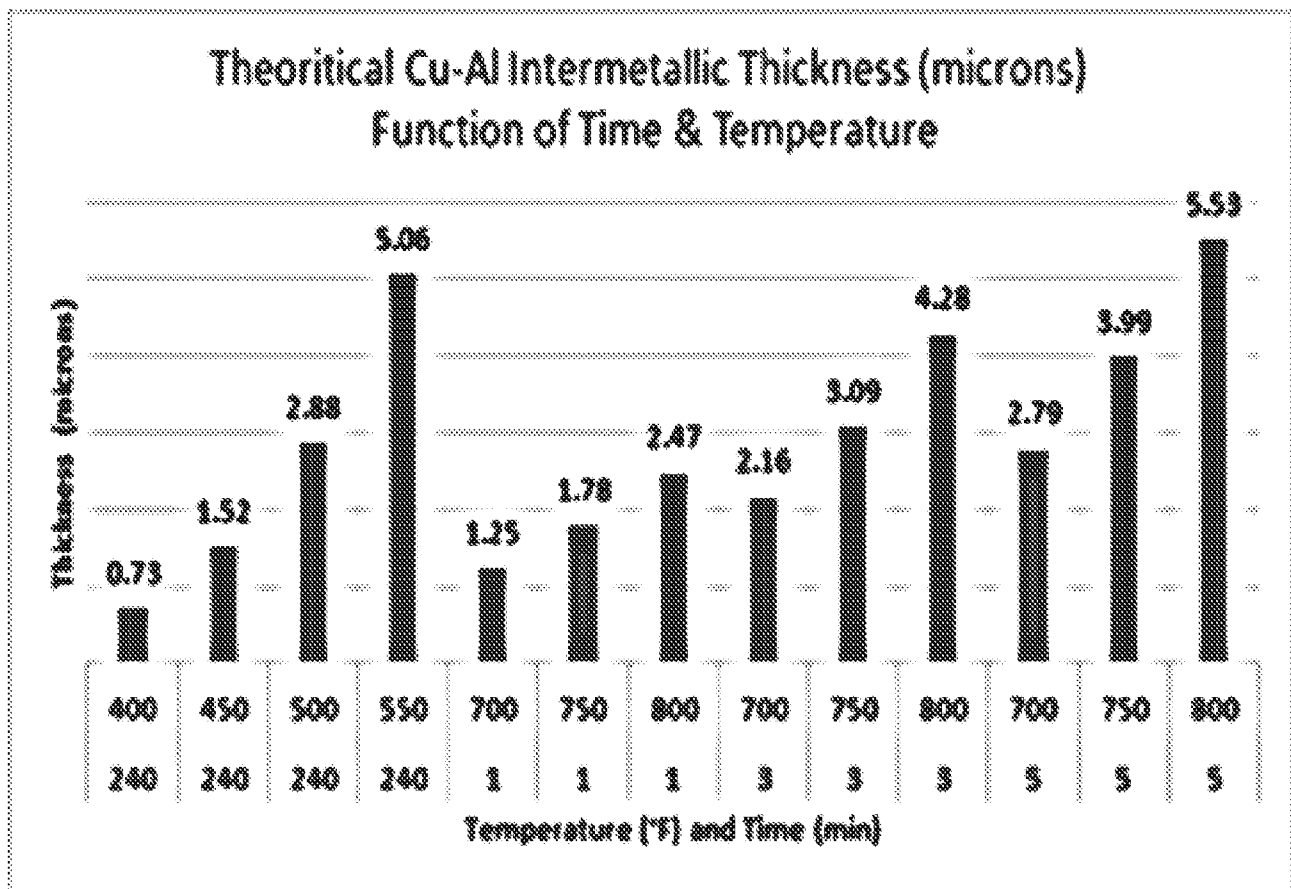


FIGURE 4

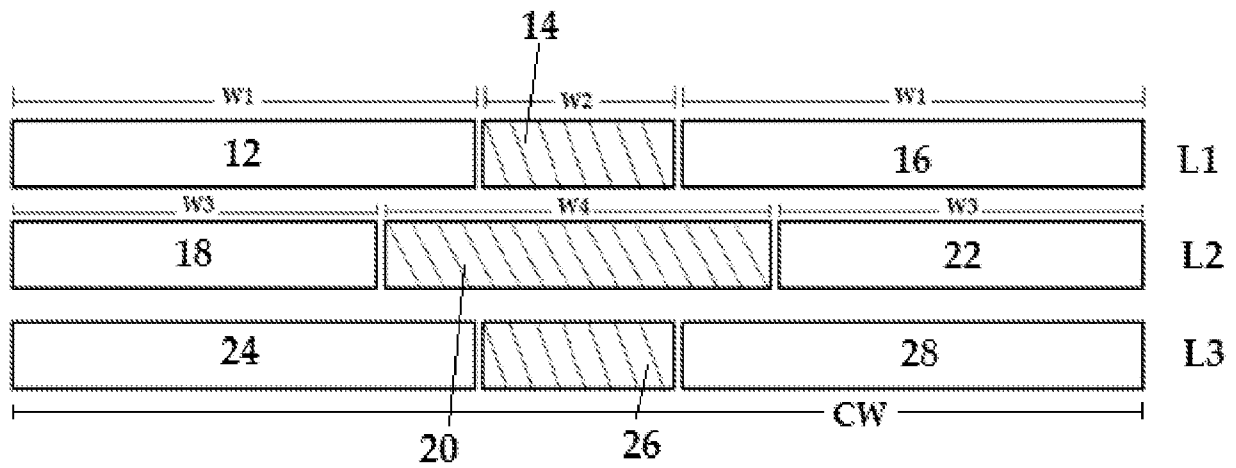


FIGURE 5A

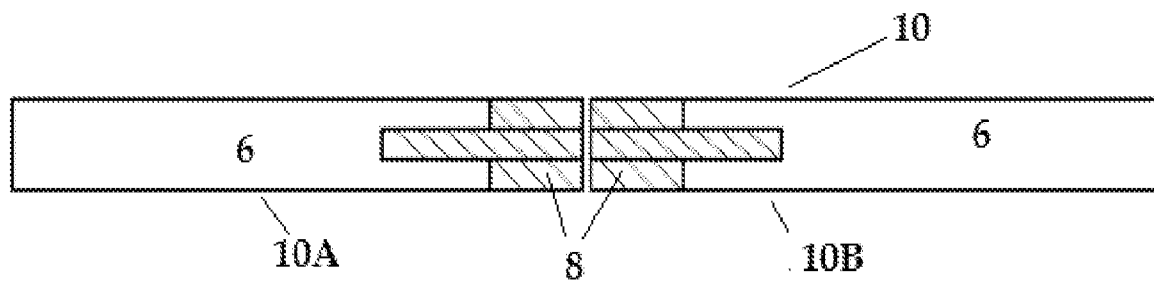


FIGURE 5B

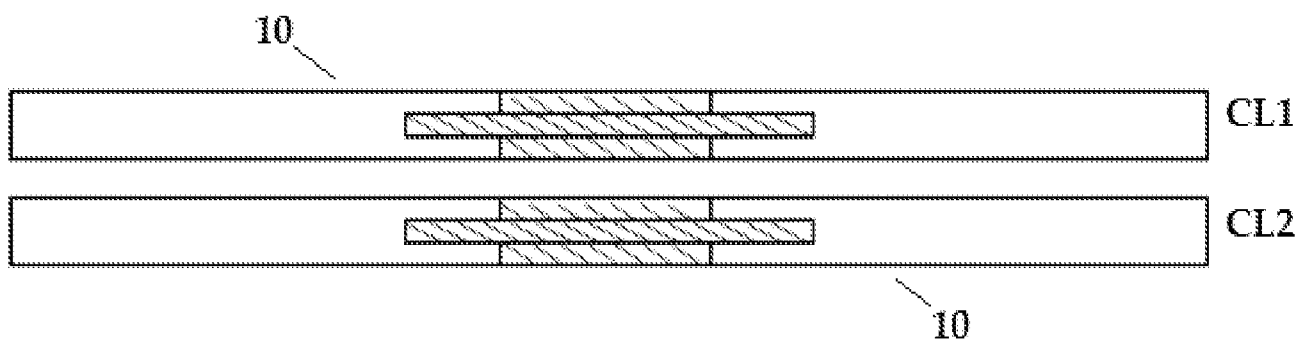


FIGURE 6A

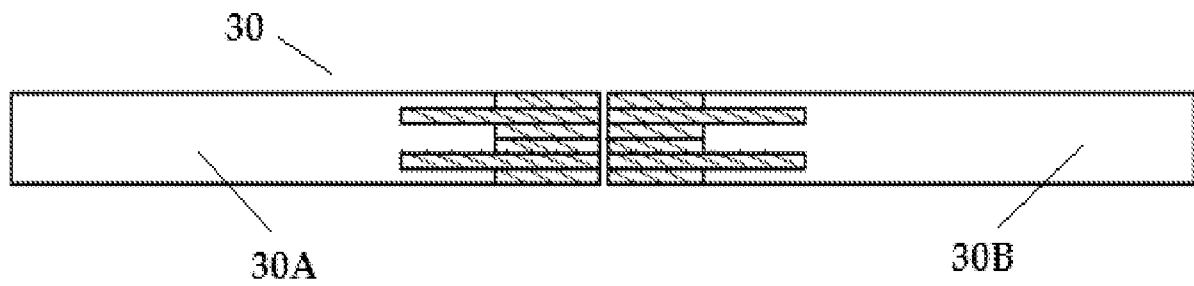


FIGURE 6B

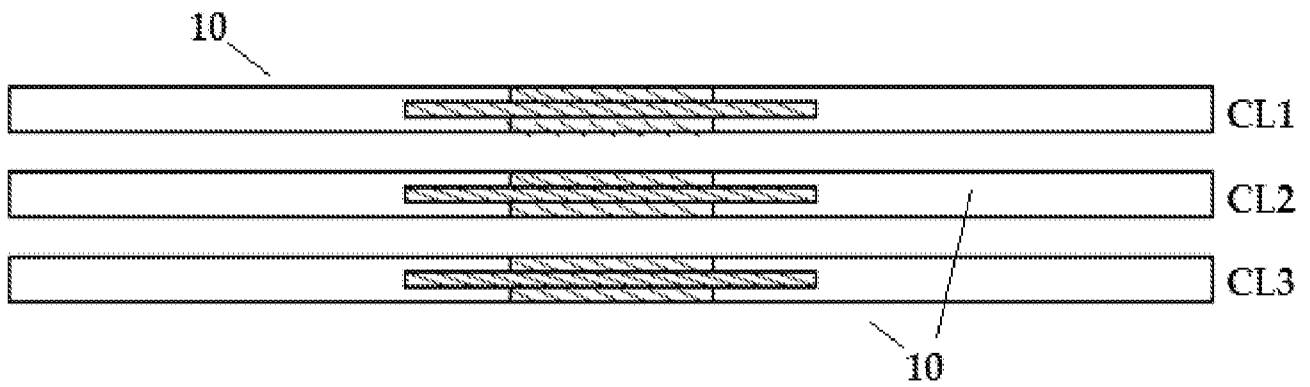


FIGURE 7A

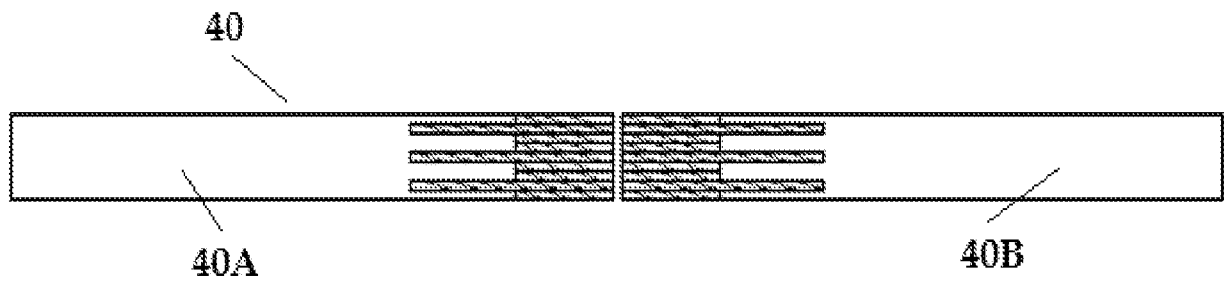


FIGURE 7B

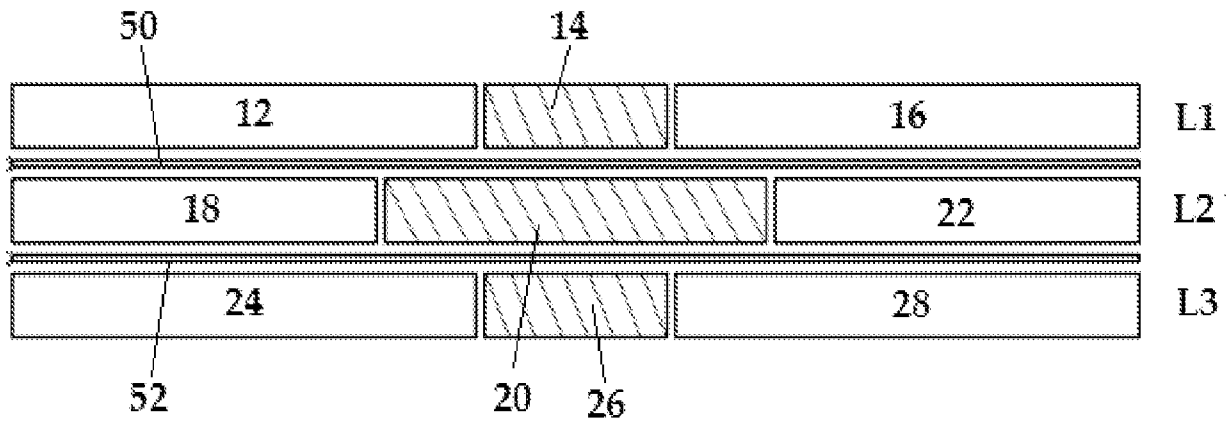


FIGURE 8A

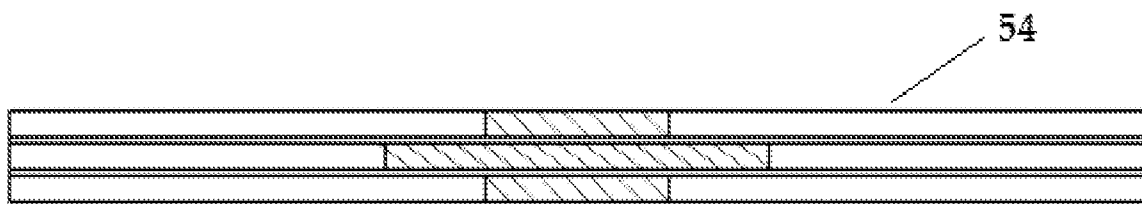


FIGURE 8B

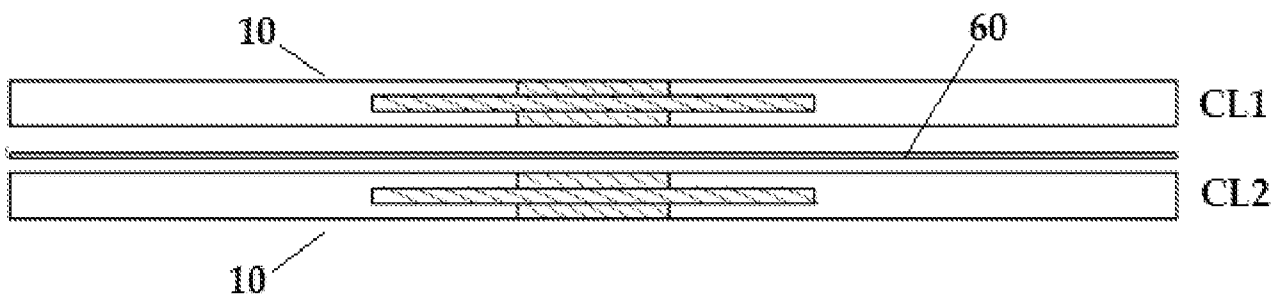


FIGURE 9A

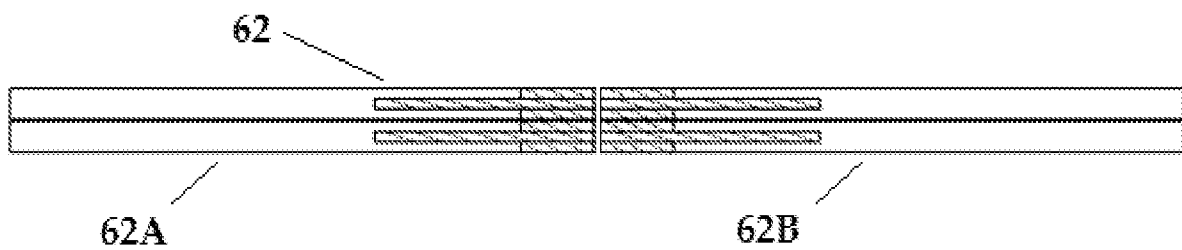


FIGURE 9B

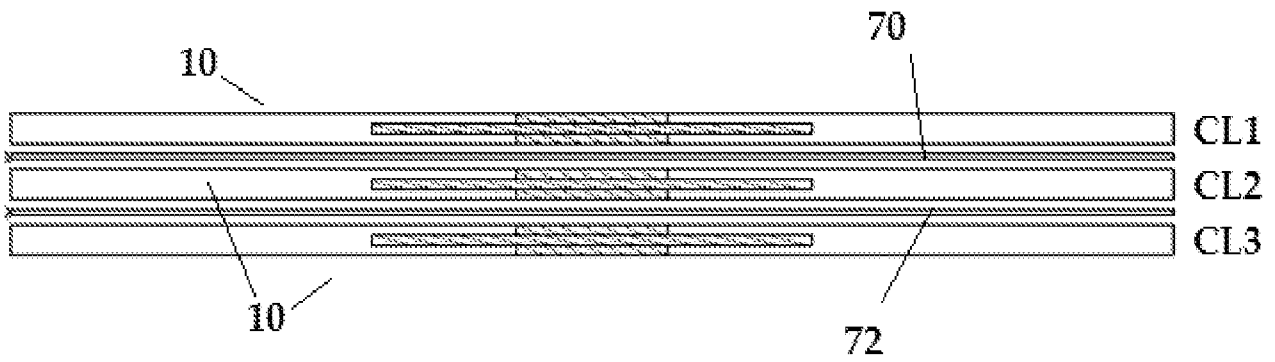


FIGURE 10A

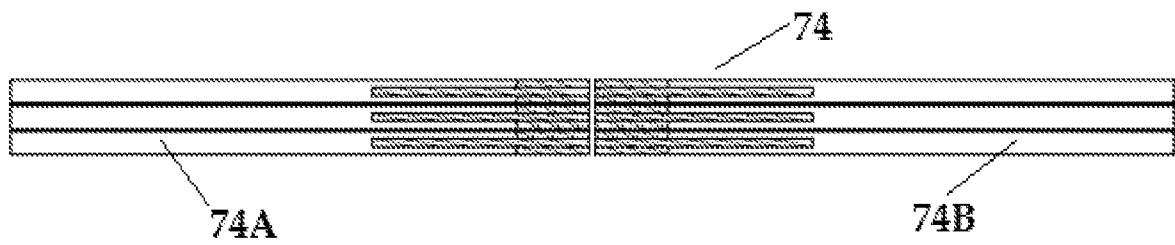
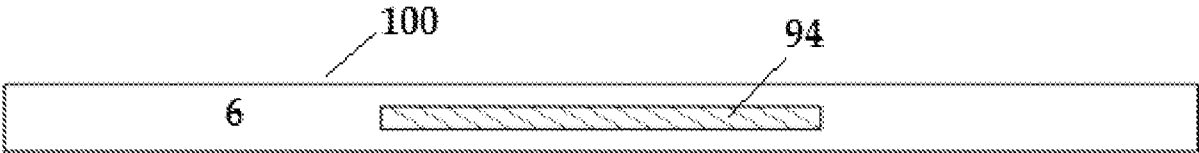
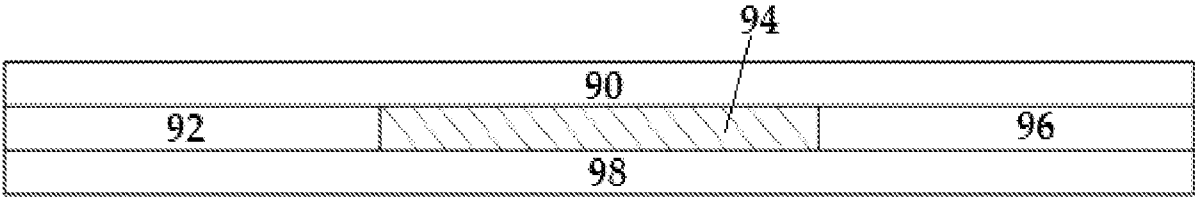
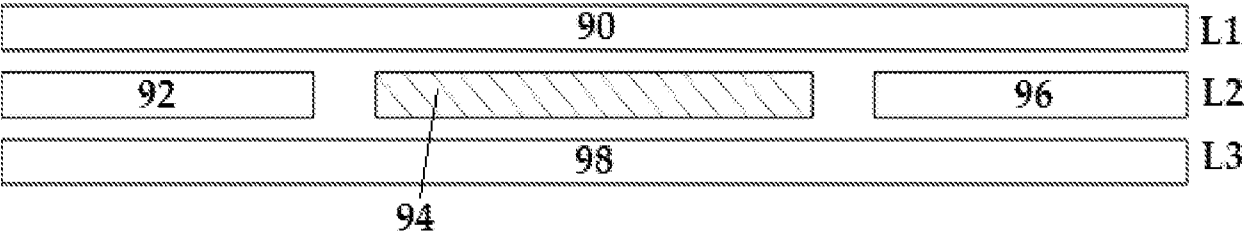


FIGURE 10B



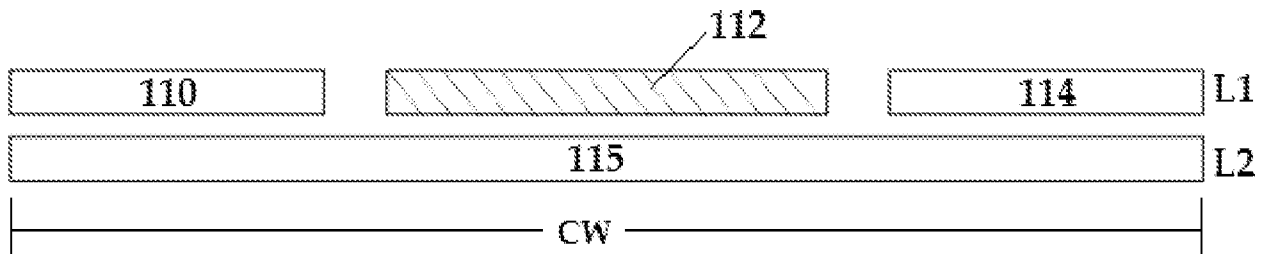


FIGURE 12A

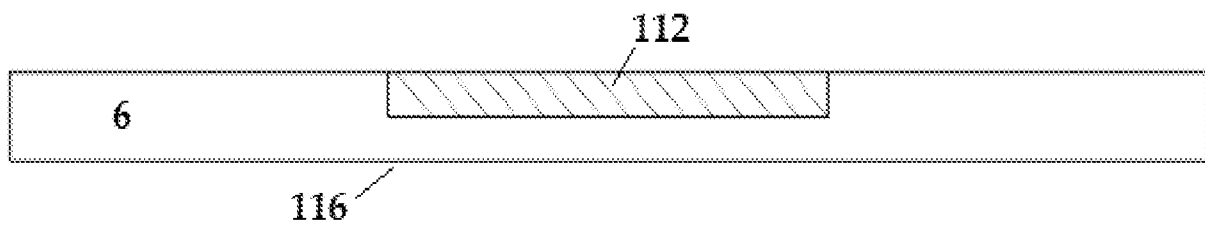


FIGURE 12B

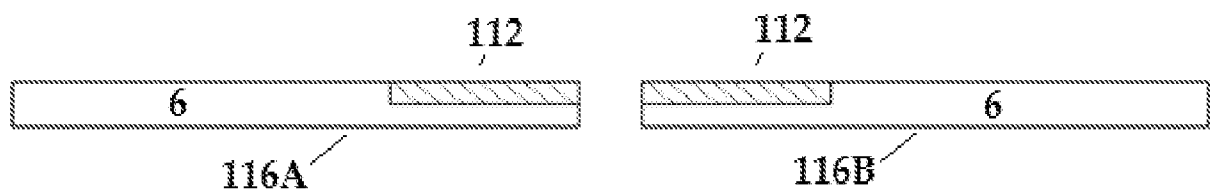


FIGURE 12C

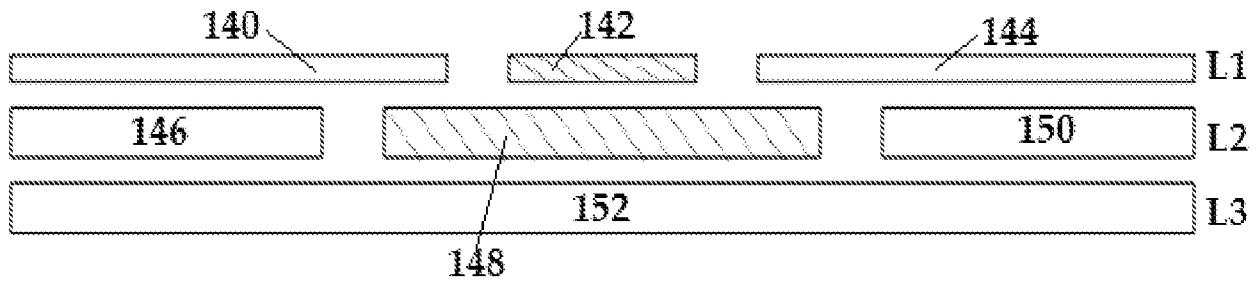


FIGURE 13A

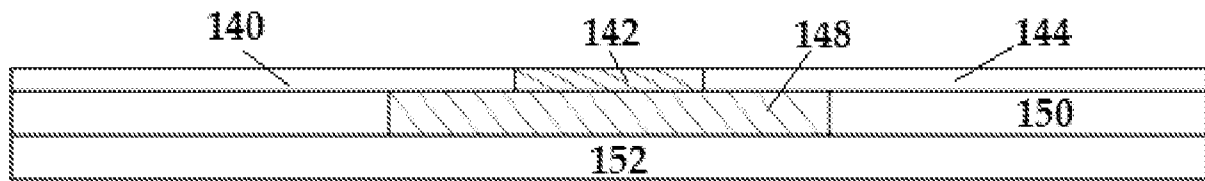


FIGURE 13B

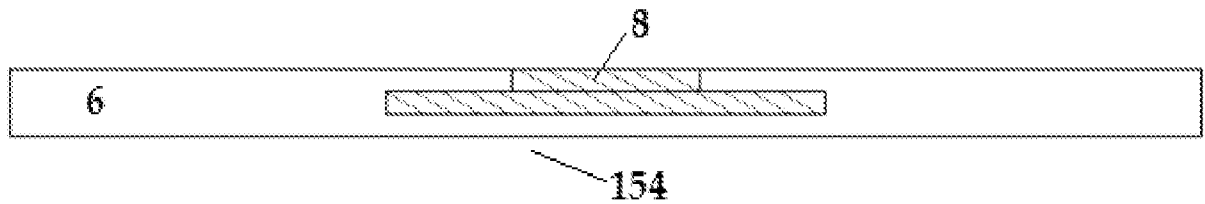


FIGURE 13C

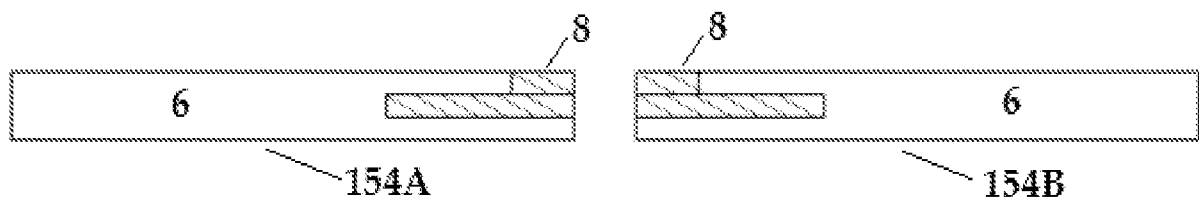


FIGURE 13D

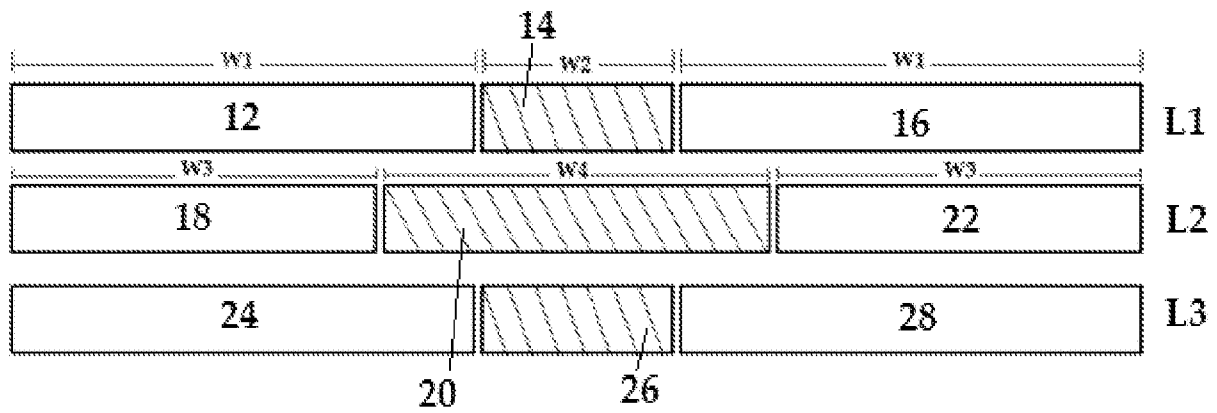


FIGURE 14A

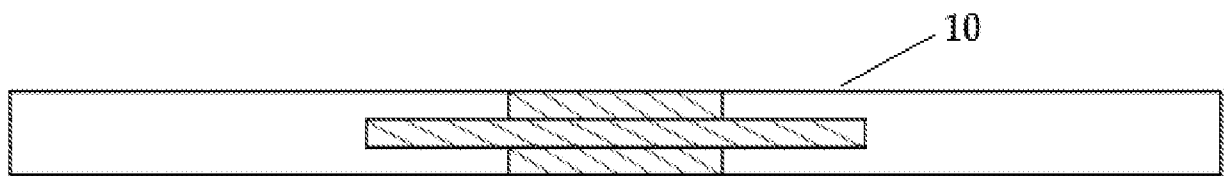


FIGURE 14B

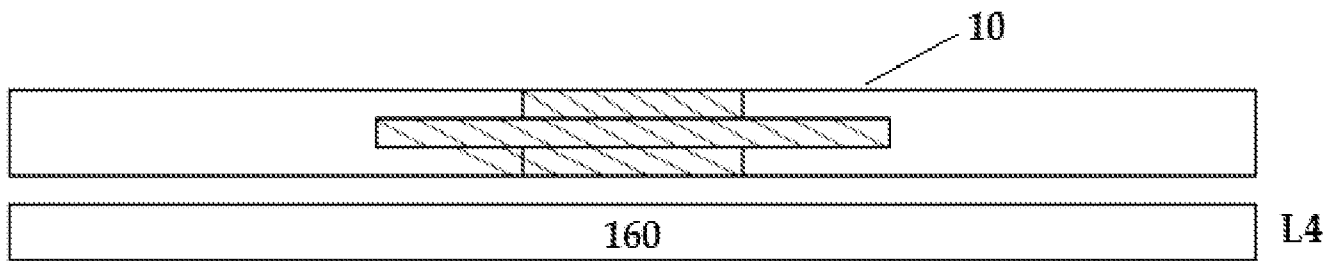


FIGURE 14C

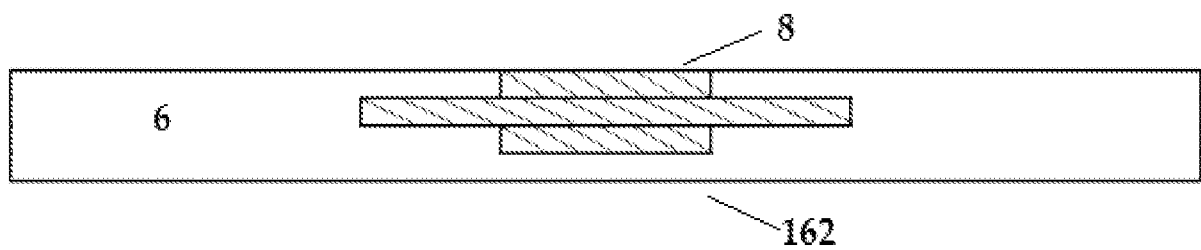


FIGURE 14D

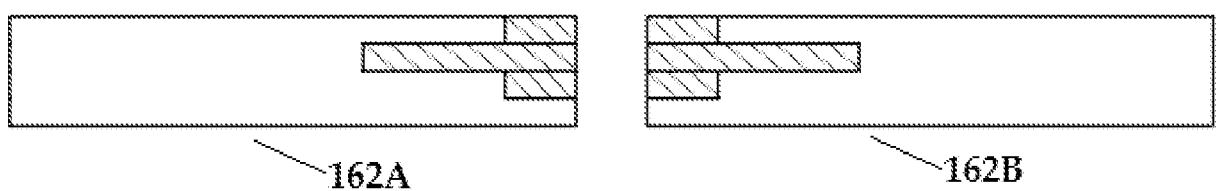


FIGURE 14E

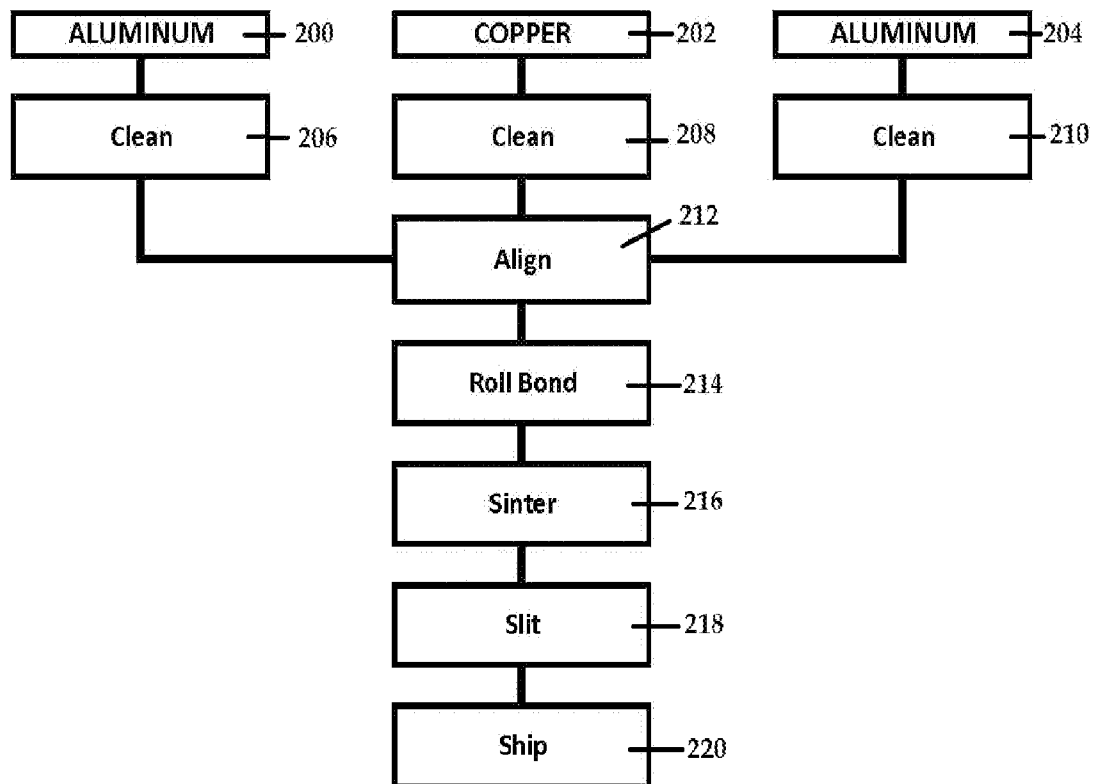
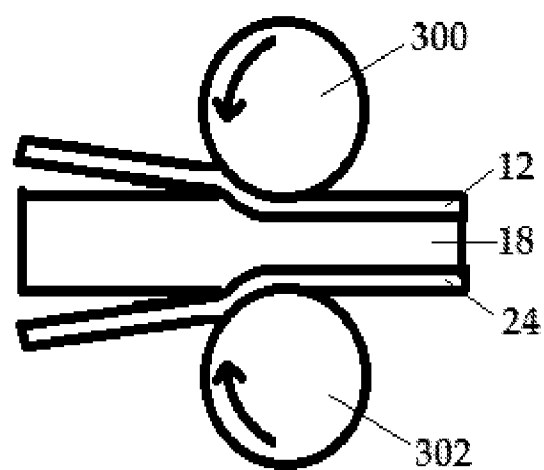


FIGURE 15



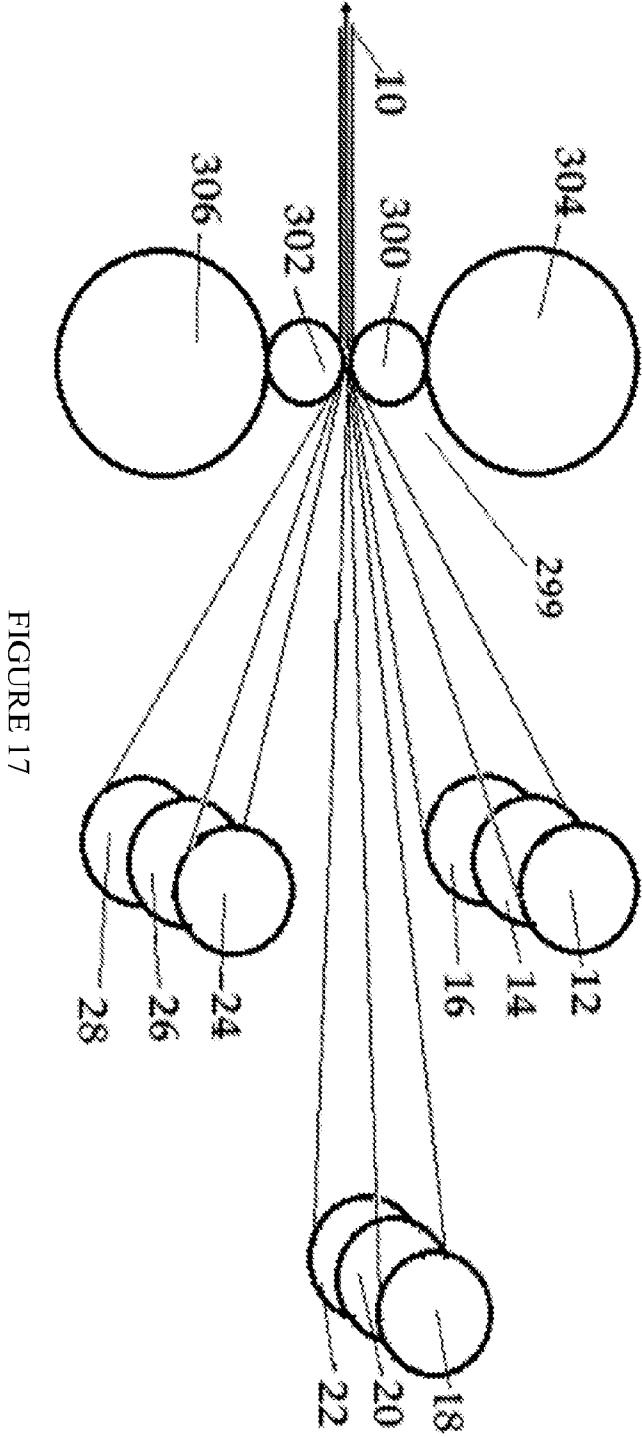


FIGURE 17

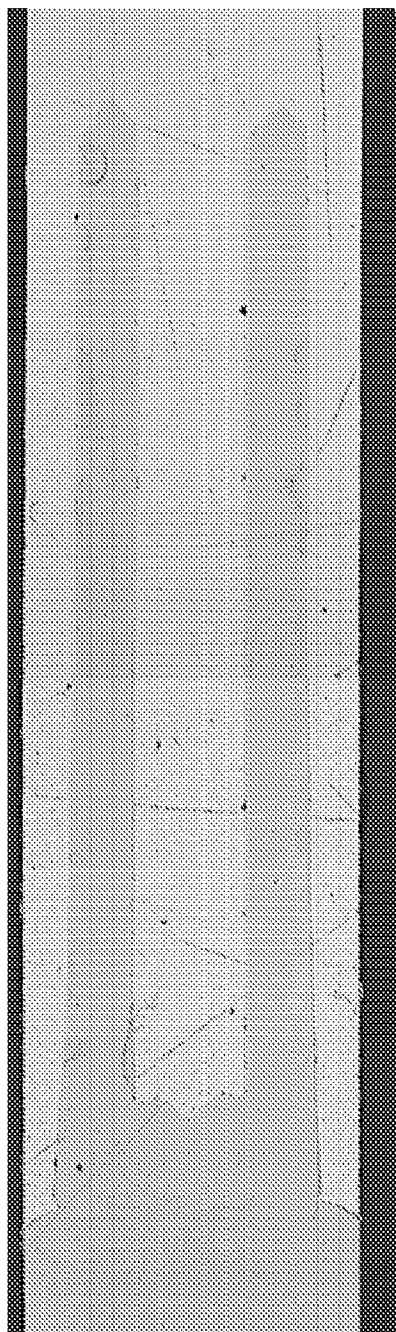


FIGURE 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/41857

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - B23K 20/00; B23K 20/22; B32B 15/01 (2015.01) CPC - B23K 20/028; Y10T 428/12486; Y10T 428/12493 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: B23K 20/00, 20/22; B32B 15/01 (2015.01) CPC: B23K 20/00, 20/028, 20/22; B32B 15/01; Y10T 428/12486, 428/12493, 428/12632; B21B15/0085, 2015/0092 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC: 228/190, 235.2; 428/614, 615, 635 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; ProQuest; Search Terms: press, roll, bond, clad, plating, strip, layer, edge-to-edge, side-by-side, butt, abut, adjoin, join, contiguous, touch, contact, stepped, inlay, copper, aluminum, steel, nickel, composite, metal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0186178 A1 (BAUDER, H.) 24 August 2006 (24.08.2006) figures 8, 12; paragraphs [0012], [0103], [0040], [0095], [0104], [0106]	13-18, 24, 25
A	US 5,429,879 A (SYN, C. et al) 04 July 1995 (04.07.1995) figure 3; column 6, lines 20-30	19
A	US 3,938,723 A (SLAUGHTER, E.) 17 February 1976 (17.02.1976) entire document	1-25
A	US 2011/0206943 A1 (WILLIS, R. et al) 25 August 2011 (25.08.2011) entire document	1-25
A	US 4,798,932 A (DION, P. et al) 17 January 1989 (17.01.1989) entire document	1-25
A	US 3,682,606 A (ANDERSON, E. et al) 08 August 1972 (08.08.1972) entire document	1-25
A	US 5,306,571 A (DOLOWY, J. et al) 26 April 1994 (26.04.1994) entire document	1-25
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 21 September 2015 (21.09.2015)		Date of mailing of the international search report 19 OCT 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774