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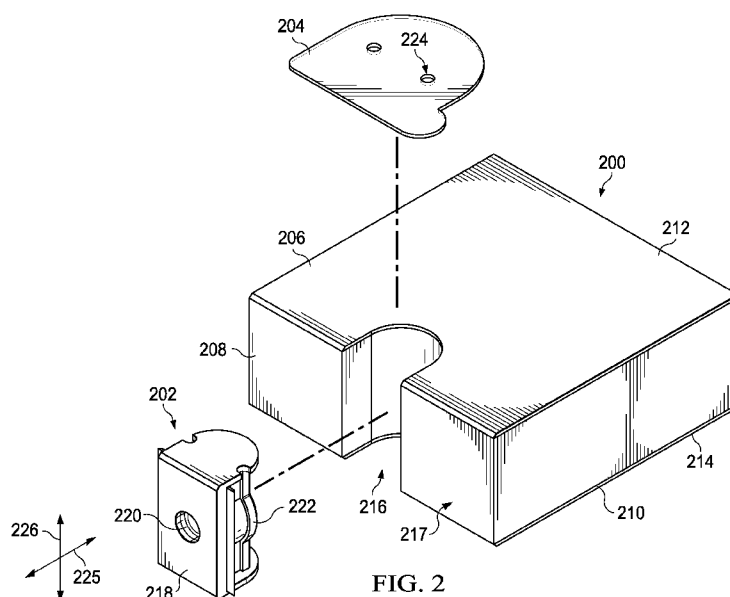
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(54) Title: APPARATUS AND METHOD FOR ASSOCIATING THE EDGE OF A COMPOSITE OBJECT WITH ANOTHER OBJECT



(57) Abstract: A method and apparatus for associating an edge of a first object 200 with a second object. An insert 202 comprising a structure holding a fastener element may be positioned within a hollow portion 216 at the edge of the first object 200. The structure may be configured to span an entire thickness of the first object 200 at the edge of the first object 200. The structure may be adhesively bonded to the first object 200. The second object may be attached to the edge of the first object using the fastener element.

**APPARATUS AND METHOD FOR ASSOCIATING THE EDGE OF A COMPOSITE
OBJECT WITH ANOTHER OBJECT**

BACKGROUND INFORMATION

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1. Field:

The present disclosure relates generally to associating objects with each other. More particularly, the present disclosure relates to a method and apparatus for associating the edge of an object with another object using an insert that may be adhesively bonded to the object at the edge of the object.

2. Background:

A composite object may be considered a sandwiched composite object when the composite object is comprised of a core layer of material that is sandwiched between a first layer of material and a second layer of material. The core layer of material may have a greater thickness than the first and second layers of material. In some cases, the core layer of material may be comprised of a honeycomb material, a foam material, or some other structure. A honeycomb material may be a material that has a honeycomb-like structure.

Oftentimes, all three of these layers may be exposed at the edge of a composite object. Attaching another object to the composite object at the edge of composite object may require using one or more fastener components that have been installed at the edge of the composite object.

As one illustrative example, a bracket may be installed at the edge of the composite object. The bracket may surround a portion of the edge of the composite object and cover a portion of the outer surface of the first layer of material and a portion of the outer surface of the second layer of material. Consequently, in some cases, a bracket may change the shape of the outer surfaces of the composite object in an undesired

manner. For example, without limitation, a bracket may change the evenness of these outer surfaces.

In another illustrative example, a fastener may be installed at the edge of the composite object using a cylindrical insert. For example, without limitation, a hole may be formed within the core layer of material at the edge of the composite object. The cylindrical insert may then be placed within this hole in the core layer of material. The fastener may then be installed within the cylindrical insert.

However, in some cases, the hole formed within the core layer of material may be rougher than desired. For example, without limitation, the edges of the hole may be uneven and rougher than desired. As a result, the cylindrical insert may not align with the hole in the core layer of material within selected tolerances. This type of misalignment may require additional processing of the hole, which may in turn, increase the overall time and/or effort needed to install the fastener. Further, in some cases, the cylindrical insert may increase the overall weight of the composite object more than desired.

Additionally, forming a hole within the core layer of material may have an undesirable effect on the structural integrity of the core layer of material. For example, without limitation, forming a hole within a honeycomb material may reduce the structural strength of the honeycomb material.

Therefore, it would be desirable to have a method and apparatus that takes into account at least some of the issues discussed above, as well as other possible issues.

SUMMARY

In one illustrative embodiment, an apparatus may comprise a fastener element and a structure. The structure may be configured to hold the fastener element such that the fastener element is exposed at an edge of an object when the structure is inserted within a hollow portion at an edge of an object. The structure may be configured to span an entire thickness of the object at the edge of the object.

In another illustrative embodiment, an insert configured for use at an edge of an object may comprise a fastener element, a structure, and a cover. The structure may be configured to be inserted within a hollow portion at the edge of the structure. The structure may be configured to span an entire thickness of the object at the edge of the object. The structure may comprise a hollow fastener chamber, a set of hollow chambers, an edge surface, a first surface, a second surface, and a number of grooves. The hollow fastener chamber may be configured to receive and hold the fastener element such that the fastener element is exposed at the edge of the object when the structure is inserted into the hollow portion of the object. The hollow fastener chamber may have a first size that is greater than a second size of the fastener element such that the fastener element may move freely within the hollow fastener chamber of the structure within a plane substantially perpendicular to an axis through the fastener element. The set of hollow chambers may be configured to reduce a weight of the structure. The edge surface may be configured to be substantially even with the edge of the structure when the structure is inserted into the hollow portion of the structure. The first surface may be configured to be substantially even with a first outer surface of the object and the second surface may be configured to be substantially even with a second outer surface of the object. The number of grooves may be configured to form a number of

openings in the structure when the structure is inserted into the hollow portion of the structure. An adhesive material may be configured to be injected into the number of openings to adhesively bond the structure to the structure. The cover may
5 be configured to cover the fastener element and the hollow fastener chamber of the structure.

In yet another illustrative embodiment, a method for associating an edge of a first object with a second object may be provided. An insert comprising a structure holding a
10 fastener element may be positioned within a hollow portion at the edge of the first object such that the fastener element is exposed at the edge of the object. The structure may be configured to span an entire thickness of the first object at the edge of the first object. The structure may be adhesively
15 bonded to the first object. The second object may be attached to the edge of the first object using the fastener element.

In still yet another illustrative embodiment, a method for associating an edge of a first object with a second object may be provided. An insert may be assembled by positioning a
20 fastener element within a hollow fastener chamber of a structure and covering the fastener element and the hollow fastener chamber using a cover. The insert may be positioned within a hollow portion at the edge of the first object such that an edge surface of the structure is substantially even with the edge of
25 the first object and such that the fastener element is exposed at the edge of the object. The structure may be configured to span an entire thickness of the first object at the edge of the first object. The structure may have a number of grooves configured to form a number of openings in the first object when
30 the structure may be inserted into the hollow portion of the first object. An adhesive material may be injected into the number of openings in the first object to adhesively bond the structure to the first object. A second object may be attached to the edge of the first object using a corresponding fastener

element configured for association with the second object within a channel extending through the fastener element held by the structure in the insert.

The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives and features thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

Figure 1 is an illustration of a manufacturing environment in the form of a block diagram in accordance with an illustrative embodiment;

Figure 2 is an illustration of an isometric view of a composite object, insert, and plate in accordance with an illustrative embodiment;

Figure 3 is an illustration of an enlarged view of an insert in accordance with an illustrative embodiment;

Figure 4 is an illustration of an exploded isometric view of an insert in accordance with an illustrative embodiment;

Figure 5 is an illustration of the exploded isometric view of the insert rotated 180 degrees in accordance with an illustrative embodiment;

Figure 6 is an illustration of the insert positioned within a hollow portion in accordance with an illustrative embodiment;

Figure 7 is an illustration of a plate positioned over the insert and a composite object in accordance with an illustrative embodiment;

Figure 8 is an illustration of adhesive material that has been injected into the composite object in accordance with an illustrative embodiment;

Figure 9 is an illustration of the insert fully adhesively bonded to the composite object in accordance with an illustrative embodiment;

Figure 10 is an illustration of an isometric view of a different configuration for an insert in accordance with an illustrative embodiment;

Figure 11 is an illustration of an exploded isometric view of an insert rotated 180 degrees in accordance with an illustrative embodiment;

Figure 12 is an illustration of an isometric view of a different configuration for an insert in accordance with an illustrative embodiment;

Figure 13 is an illustration of an exploded isometric view of an insert rotated 180 degrees in accordance with an illustrative embodiment;

Figure 14 is an illustration of a process for associating an edge of a first object with a second object in the form of a flowchart in accordance with an illustrative embodiment;

Figure 15 is an illustration of an aircraft manufacturing and service method in the form of a block diagram in accordance with an illustrative embodiment; and

Figure 16 is an illustration of an aircraft in the form of a block diagram in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

The different illustrative embodiments recognize and take into account different considerations. In particular, the

illustrative embodiments recognize and take into account that it may be desirable to have an insert that may be installed at the edge of a composite object without reducing the structural integrity of the composite object more than desired. Further, the illustrative embodiments recognize and take into account that it may be desirable to have an insert that may be installed at the edge of a composite object without taking more time and/or effort than desired.

Thus, the illustrative embodiments provide a method and apparatus for associating an edge of a first object with a second object. In one illustrative embodiment, a method and apparatus for associating an edge of a first object with a second object may be provided. An insert comprising a structure holding a fastener element may be positioned within a hollow portion at the edge of the first object. The structure may be configured to span an entire thickness of the first object at the edge of the first object. The structure may be adhesively bonded to the first object. The second object may be attached to the edge of the first object using the fastener element.

Referring now to the figures and, in particular, with reference now to **Figure 1**, an illustration of a manufacturing environment in the form of a block diagram is depicted in accordance with an illustrative embodiment. In **Figure 1**, manufacturing environment **100** may be an example of an environment in which structures may be associated with each other. In these illustrative examples, first object **102** and second object **104** may be configured for association with each other within manufacturing environment **100**.

A component, such as second object **104**, may be considered to be associated with another component, such as first object **102**, by being secured, attached, bonded, fastened, and/or mounted to the other component. Additionally, a component may be associated with another component by being connected to the other component in some other suitable manner. In some cases, a

component also may be connected to another component by using yet another component. In other illustrative examples, a component may be considered to be associated with another component by being formed as part of and/or as an extension of the other component.

In these illustrative examples, first object **102** may take the form of composite object **108**. In particular, first object **102** may be comprised of first layer **110**, second layer **112**, and core **114**. In these illustrative examples, core **114** may be located in between first layer **110** and second layer **112**. In other words, core **114** may be "sandwiched" between first layer **110** and second layer **112**. In this manner, first object **102** may be referred to as a "sandwiched composite object" or a "sandwiched-structure composite".

The surface of first layer **110** not in contact with core **114** may form first outer surface **116** of first object **102**. Further, the surface of second layer **112** not in contact with core **114** may form second outer surface **118** of first object **102**.

First layer **110** and second layer **112** of first object **102** may be comprised of any number of different materials. These materials may include, for example, without limitation, a composite material, metal, plastic, and/or other suitable types of materials. In some cases, these layers may be comprised of one or more composite materials including, but not limited to, glass-reinforced plastic, carbon fiber-reinforced plastic (CFRP), thermoplastic, a thermoset polymer, a composite polymer, and/or other types of composite materials.

In one illustrative example, first layer **110** and second layer **112** may take the form of pre-impregnated composite fiber panels, also referred to as prepreg panels or prepregs. In some cases, first layer **110** and second layer **112** may be referred to as face sheets or skins.

Depending on the implementation, core **114** may take the form of honeycomb core **120** or foam core **122**. Honeycomb core **120** may

be a layer of material comprising an array of hollow cells defined by walls. These cells may have, for example, without limitation, a cylindrical shape, a cuboidal shape, a prism-type shape, a hexagonal shape, or some other type of shape. Foam
5 core **122** may be, for example, without limitation, a layer of material comprised of, for example, without limitation, an open-cell foam material, a closed-cell foam material, or some other type of foam material.

Of course, in other illustrative examples, core **114** may
10 take a different form. For example, without limitation, **114** may take the form of a lattice structure, an arrangement of rods and/or other types of elongate members, a mesh structure, or some other type of structure.

Further, core **114** of first object **102** may be comprised of
15 any number of different materials. In particular, core **114** may be a light-weight structure comprised of any selection of materials configured to allow core **114** to hold first layer **110** and second layer **112** a fixed distance apart during locating. The selection of materials may include, for example, without
20 limitation, polyurethane, aluminum, glass-reinforced plastic such as fiberglass, carbon fiber-reinforced plastic, a thermoplastic material, an aramid fiber material, a meta-aramid material, a foam material, and/or other types of materials.

Second object **104** may take a number of different forms.
25 Second object **104** may be any type of object that is configured for association with edge **106** of first object **102**. For example, without limitation, second object **104** may take the form of a trim, an edge-mount step, a handhold, a quarter turn object, a hinge, a wire tie, a bracket, a trim material, or some other
30 type of object configured to be attached to edge **106** of first object **102**.

As depicted, edge **106** of first object **102** may span the entire thickness **124** of first object **102**. When first object **102**, takes the form of composite object **108**, edge **106** may be any

edge at which each of first layer **110**, second layer **112**, and core **114** are exposed. In particular, edge **106** may span the entire thickness **124** that includes the thicknesses of each of first layer **110**, second layer **112**, and core **114** may be exposed.

5 Further, edge **106** of first object **102** may be substantially perpendicular to first outer surface **116** of first object **102** and substantially perpendicular to second outer surface **118** of first object **102** in these illustrative examples. Of course, in some cases, edge **106** may be at some other angle relative to first
10 outer surface **116** and/or second outer surface **118**. However, in these illustrative examples, edge **106** may not be substantially parallel to first outer surface **116** or second outer surface **118**.

Second object **104** may be associated with first object **102** using insert **134**. Insert **134** may be configured to be positioned
15 within hollow portion **126** of first object **102** at edge **106**. In these illustrative examples, hollow portion **126** may be formed within first object **102** at edge **106** of first object **102** using tool **128**. In particular, tool **128** may be used to remove a portion of first object **102** to form hollow portion **126**. Hollow
20 portion **126** may be formed such that hollow portion **126** spans the entire thickness **124** of first object **102** at edge **106** of first object **102**. In other words, the portion removed from first object **102** may include portions of first layer **110**, core **114**, and second layer **112**.

25 Tool **128** may take the form of, for example, without limitation, router **130**, laser device **132**, or some other type of cutting tool. Using, for example, without limitation, router **130** to cut away a portion of first object **102** to form hollow portion **126** may be easier and require less effort than forming a
30 hole within core **114** alone.

Hollow portion **126** may be formed such that insert **134** may be substantially entirely inserted within hollow portion **126**. Insert **134** may then be used to attach second object **104** to first object **102** at edge **106**. As depicted, insert **134** may include

structure **136**, fastener element **138**, and cover **140**. When insert **134** is positioned with hollow portion **126** of first object **102**, fastener element **138** may be exposed at edge **106** and prepared to receive another fastener element.

5 In these illustrative examples, structure **136** may have outer side **142**, inner side **144**, first side **146**, and second side **148**. In particular, structure **136** may have first surface **150** and second surface **152** at first side **146** and second side **148**, respectively. Structure **136** may also have edge surface **154** at
10 outer side **142**. Edge surface **154** at outer side **142** of structure **136** may be the surface of structure **136** that is exposed at edge **106** of first object **102** when structure **136** is inserted within hollow portion **126**.

 As depicted, edge surface **154** may have opening **156** that
15 extends through structure **136**. Opening **156** may only be located along edge surface **154** in these examples. In other words, opening **156** may not be located along first surface **150** or second surface **152** of structure **136**.

 Edge surface **154** of structure **136** may be configured to be
20 substantially even with edge **106** of first object **102** when structure **136** is inserted within hollow portion **126**. Further, first surface **150** and second surface **152** of structure **136** may be configured to be substantially even with first outer surface **116** and second outer surface **118**, respectively, of first object **102**
25 when structure **136** is inserted within hollow portion **126**.

 In other words, edge surface **154**, first surface **150**, and second surface **152** may be substantially flush with edge **106** of first object **102** when structure **136** is inserted within hollow portion **126**. In these illustrative examples, structure **136** may
30 be shaped such that structure **136**, and thereby insert **134** are substantially flush with all portions of first object **102** when insert **134** is positioned within hollow portion **126** of first object **102**.

In these illustrative examples, structure **136** may be configured to hold fastener element **138**. Fastener element **138** may take any number of forms depending on the implementation. In one illustrative example, fastener element **138** may take the form of a nut having threads configured to receive another threaded fastener element, such as a screw.

As depicted, hollow fastener chamber **158** of structure **136** may be configured to receive and hold fastener element **138**. In one illustrative example, hollow fastener chamber **158** may have a first size that is greater than a second size of fastener element **138**. As one illustrative example, hollow fastener chamber **158** may have a greater diameter than the diameter of fastener element **138**. In this manner, fastener element **138** may be configured to move freely within hollow fastener chamber **158** of structure **136**. In one illustrative example, fastener element **138** may be configured to move freely within a plane substantially perpendicular to an axis through fastener element **138**. In other words, fastener element **138** may be allowed to "float" within hollow fastener chamber **158**.

Additionally, structure **136** may have set of hollow chambers **160**. As used herein, a "set of" items may be zero or more items. In this manner, a set of items may be a null or empty set in some cases. In these illustrative examples, set of hollow chambers **160** may include zero, two, four, or some other number of hollow chambers. Set of hollow chambers **160** may be configured to reduce the weight of structure **136**.

Once insert **134** has been positioned within hollow portion **126**, insert **134** may be adhesively bonded to first object **102**. As one illustrative example, structure **136** may have number of grooves **164** at first side **146** of structure **136**. When structure **136** is inserted within hollow portion **126** of first object **102**, number of grooves **164** may form number of openings **166** at first side **146** of structure **136**.

As used herein, a "number of" items may be one or more items. In this manner, number of grooves **164** may include one or more grooves and number of openings **166** may include one or more openings.

5 Number of openings **166** may open into air pockets that may be around and/or within hollow portion **126** within core **114** around structure **136**. Adhesive material **168** may be injected into these air pockets through number of openings **166**. Adhesive material **168** may take the form of, for example, without
10 limitation, a potting compound.

 In one illustrative example, plate **170** may be positioned such that plate **170** covers at least a portion of first surface **150** of structure **136** and at least a portion of first outer surface **116** of first object **102**. In particular, plate **170** may
15 have number of plate openings **172** that correspond to number of openings **166**. Plate **170** may be positioned such that number of plate openings **172** may be substantially aligned with number of openings **166**.

 When adhesive material **168** is injected into number of
20 openings **166**, any excess of adhesive material **168** that spills over onto plate **170** without contacting first surface **150** of structure **136** or first outer surface **116** of first object **102**. In other words, plate **170** may catch overflow of adhesive material **168** to prevent adhesive material **168** from contacting
25 first outer surface **116** of first object **102**.

 Plate **170** may be removed and adhesive material **168** may be allowed to harden such that insert **134** is adhesively bonded to first object **102**. Once insert **134** is adhesively bonded to first object **102**, loads may be transferred between insert **134** and
30 first layer **110** and second layer **112** through adhesive material **168**.

 In these illustrative examples, fastener element **138** may have channel **161** that extends through fastener element **138**. When fastener element **138** is positioned within hollow fastener

chamber **158** of structure **136**, channel **161** may extend through at least a portion of opening **156** in structure **136**. Opening **156** allows channel **161** through fastener element **138** to be exposed at edge **106** of first object **102**. In this manner, fastener element **138** may be prepared to receive corresponding fastener element **162** into channel **161** of fastener element **138** through opening **156** in structure **136**.

Corresponding fastener element **162** may be another fastener element that is configured for association with second object **104**. In one illustrative example, corresponding fastener element **162** may be a screw. Corresponding fastener element **162** may be inserted through opening **156** into channel **161** at edge **106** in a direction that is substantially perpendicular to edge **106**. In some cases, corresponding fastener element **162** may be inserted at edge **106** at some other angle relative to edge **106**.

When corresponding fastener element **162** is inserted through opening **156** at edge surface **154** of structure **136**, at least a portion of corresponding fastener element **162** enters channel **161** of fastener element **138**. Insertion of corresponding fastener element **162** into channel **161** may cause fastener element **138** to move freely within hollow fastener chamber **158** of structure **136**. In particular, fastener element **138** may move such that channel **161** through fastener element **138** may substantially align with corresponding fastener element **162** within selected tolerances. In this manner, corresponding fastener element **162** may be used to attach second object **104** to first object **102** at edge **106** of structure.

The illustration of manufacturing environment **100** and insert **134** in **Figure 1** is not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to or in place of the ones illustrated may be used. Some components may be optional. Also, the blocks are presented to illustrate some functional components. One or more of these

blocks may be combined, divided, or combined and divided into different blocks when implemented in an illustrative embodiment.

Although insert **134** is depicted with structure **136** holding one fastener element, fastener element **138**, structure **136** may be configured to hold more than one fastener element within one or more respective hollow fastener chambers. For example, without limitation, insert **134** may be configured to hold two different types of fastener elements within two different hollow fastener chambers.

Further, although insert **134** is depicted as spanning the entire thickness **124** of first object **102**, insert **134** may be configured to span the entire of thickness of two objects that have been stacked on top of each other to form a common edge. For example, without limitation, first object **102** and another object (not shown) may be stacked on top of each other to form a common edge that includes edge **106** and a corresponding edge (not shown) of the other object. Insert **134** may be configured to span the entire thickness of this common edge. In some cases, with this type of configuration, insert **134** may be configured to hold multiple fastener elements that may be installed into these structures. Of course, in some illustrative examples, first object **102** may be comprised of multiple objects; thickness **124** of first object **102** may include the thicknesses of these multiple objects; and edge **106** may be the common edge formed by these multiple objects.

In other illustrative examples, fastener element **138** may not be allowed to move freely within hollow fastener chamber **158**. Rather, fastener element **138** and hollow fastener chamber **158** may be sized such that an interference fit is formed when fastener element **138** is placed within hollow fastener chamber **158**.

With reference now to **Figure 2**, an illustration of an isometric view of a composite object, insert, and plate is depicted in accordance with an illustrative embodiment. In

Figure 2, composite object **200**, insert **202**, and plate **204** may be examples of implementations for composite object **108**, insert **134**, and plate **170**, respectively, in **Figure 1**.

In this illustrative example, composite object **200** may be comprised of first layer **206**, core **208**, and second layer **210**, which may be examples of implementations for first layer **110**, core **114**, and second layer **112**, respectively, in **Figure 1**. As depicted, core **208** is sandwiched between first layer **206** and second layer **210**. First layer **206** may form first outer surface **212** of composite object **200**, while second layer **210** may form second outer surface **214** of composite object **200**. First outer surface **212** and second outer surface **214** may be examples of implementations for first outer surface **116** and second outer surface **118**, respectively, in **Figure 1**.

Hollow portion **216** may be present within composite object **200** at edge **217** of composite object **200**. Hollow portion **216** may be an example of one implementation for hollow portion **126** in **Figure 1**. Further, edge **217** may be an example of one implementation for edge **106** in **Figure 1**.

In this illustrative example, hollow portion **216** may have been formed using, for example, without limitation, a router (not shown). Insert **202** may be configured to be positioned within hollow portion **216**. In particular, insert **202** may be configured such that insert **202** may substantially conform to hollow portion **216**.

As depicted, insert **202** may include structure **218**, fastener element **220**, and cover **222**. Structure **218**, fastener element **220**, and cover **222** may be examples of implementations for structure **136**, fastener element **138**, and cover **140**, respectively, in **Figure 1**.

Insert **202** may be positioned within hollow portion **216** and adhesively bonded to composite object **200**. In particular, insert **202** may be adhesively bonded to composite object **200** using plate **204** having number of openings **224**. Number of

openings **224** may be an example of one implementation for number of plate openings **172** in **Figure 1**. The process by which insert **202** may be adhesively bonded to composite object **200** is described in **Figures 7-9**.

5 A second composite object (not shown) may be attached to composite object **200** using insert **202** and a corresponding fastener element (not shown). In particular, the second composite object (not shown) may be attached to edge **217** of composite object **200** by inserting the corresponding fastener
10 element (not shown) into fastener element **220** in a direction substantially parallel to axis **225**. Axis **225** is the center axis through fastener element **220** in this example.

 In this illustrative example, axis **225** is substantially perpendicular to edge **217** and substantially parallel to first
15 outer surface **212** and second outer surface **214**. Axis **226** is substantially perpendicular to axis **225** and to first outer surface **212** and second outer surface **214**. In this illustrative example, axis **226** is substantially parallel to edge **217**.

 Turning now to **Figure 3**, an illustration of an enlarged
20 view of insert **202** from **Figure 2** is depicted in accordance with an illustrative embodiment. As depicted, structure **218** belonging to insert **202** may have first side **300**, second side **302**, outer side **304**, and inner side **306**. In particular, structure **218** may have first surface **305** at first side **300**,
25 second surface **307** at second side **302**, and edge surface **308** at outer side **304**. In this illustrative example, opening **310** may be present in edge surface **308** at outer side **304** of structure **218**.

 Axis **225** through fastener element **220** may be substantially
30 perpendicular to edge surface **308** in this illustrative example. However, in some cases, fastener element **220** may be positioned such that axis **225** through fastener element **220** is at some other angle relative to edge surface **308**.

As depicted, structure **218** may have number of grooves **312** at first side **300**. Number of grooves **312** may be an example of one implementation for number of grooves **164** in **Figure 1**. Number of grooves **312** may include groove **314** and groove **316**.

5 Additionally, in this illustrative example, structure **218** may also include a number of flanges that include flange **318** and flange **320**. In some cases, these flanges may also be referred to as tabs. Flange **318** and flange **320** may be flexible at the interface between each of these flanges and structure **218**. In
10 other words, flange **318** and flange **320** may be rotated relative to structure **218** at the corresponding interfaces between flange **318** and flange **320**.

Flange **318** and flange **320** may be configured to hold the adhesive material used to bond insert **202** to composite object
15 **200** in **Figure 2** within hollow portion **216**. In particular, flange **318** and flange **320** may be configured to reduce the flow of adhesive material at outer side **304** of structure **218** such that the adhesive material does not squeeze outside of and around insert **202**.

20 As depicted, fastener element **220** may have channel **322** that extends through fastener element **220**. Opening **310** in structure **218** may at least partially overlap with channel **322** in this illustrative example.

With reference now to **Figure 4**, an illustration of an exploded isometric view of insert **202** from **Figure 3** is depicted
25 in accordance with an illustrative embodiment. In this illustrative example, fastener element **220** and cover **222** may be more clearly seen. As depicted, fastener element **220** may be comprised of first portion **402** and second portion **404**. Channel
30 **322** may extend through both first portion **402** and second portion **404**.

Cover **222** may have surface **406** configured to cover fastener element **220**. Surface **406** may be substantially planar in this illustrative example. Additionally, cover **222** may have

protrusion **408**. Protrusion **408** may be configured to protrude into core **208** of composite object **200** from **Figure 2** when insert **202** may be positioned within hollow portion **216** of composite object **200** in **Figure 2**.

5 With reference now to **Figure 5**, an illustration of the exploded isometric view of insert **202** from **Figure 4** rotated about 180 degrees about axis **226** is depicted in accordance with an illustrative embodiment. As depicted in **Figure 5**, structure **218** may have hollow fastener chamber **500**, hollow chamber **502**,
10 and hollow chamber **504**. Hollow fastener chamber **500** may be an example of one implementation for hollow fastener chamber **158** in **Figure 1**. Hollow fastener chamber **500** may be configured to receive and hold fastener element **220**.

 Further, hollow chamber **502** and hollow chamber **504** may be
15 examples of implementations for hollow chambers that may be included in set of hollow chambers **160** in **Figure 1**. Hollow chamber **502** and hollow chamber **504** may be configured to reduce the weight of structure **218**.

 Cover **222** may be configured to cover hollow fastener
20 chamber **500**, fastener element **220** held within hollow fastener chamber **500**, hollow chamber **502**, and hollow chamber **504**. In this manner, any adhesive material injected into hollow portion **216** in **Figure 2** when insert **202** is positioned within hollow portion **216** may not enter hollow fastener chamber **500**, hollow
25 chamber **502**, and hollow chamber **504**.

 Further, structure **218** may have structural feature **506** and structural feature **508**. These structural features may aid structure **218** in adhering to composite object **200** within hollow portion **216**.

30 Turning now to **Figure 6**, an illustration of insert **202** from **Figures 2-5** positioned within hollow portion **216** from **Figure 2** is depicted in accordance with an illustrative embodiment. In this illustrative example, insert **202** may have been inserted

into hollow portion **216** such that structure **218** substantially conforms to hollow portion **216**.

Further, insert **202** may be inserted within hollow portion **216** such that edge surface **308** of structure **218** is substantially even with edge **219** of composite object **200**. Additionally, insert **202** may be inserted within hollow portion **216** from **Figure 2** such that first surface **305** and second surface **307** of structure **218** are substantially even with first outer surface **212** and second outer surface **214**, respectively, of composite object.

As depicted, groove **314** and groove **316** may form opening **600** and opening **602**, respectively, into composite object **200** when insert **202** is positioned within hollow portion **216**. Opening **600** and opening **602** may extend into core **208** of composite object **200** and, in particular, may extend into any remaining hollow portion of composite object left by hollow portion **216** after insert **202** is inserted within hollow portion **216**.

In this illustrative example, edge **217** may have chamfered corner **604** between core **208** and first layer **206** and chamfered corner **606** between core **208** and second layer **210**. Structure **218** may have chamfered corner **608** and chamfered corner **610** configured to correspond to chamfered corner **604** and chamfered corner **606**, respectively. Chamfered corner **608** and chamfered corner **610** of structure **218** may be configured such that any material, such as, for example, without limitation, a trim material, that is wrapped around edge **217** of composite object **200** over a portion of first outer surface **212** and/or second outer surface **214** may lie substantially flush with these outer surfaces.

With reference now to **Figure 7**, an illustration of plate **204** from **Figure 2** positioned over insert **202** and composite object **200** from **Figure 6** is depicted in accordance with an illustrative embodiment. In this illustrative example, number

of openings **224** in plate **204** may be an example of one implementation for number of plate openings **172** in **Figure 1**.

Number of openings **224** may include opening **700** and opening **702**. Opening **700** and opening **702** may correspond to opening **600** and opening **602**, respectively, into composite object **200**. Plate **204** may be positioned over composite object **200** such that plate **204** overlaps both first surface **305** of structure **218** of insert **202** and first outer surface **212** of composite object **200**.

Further, plate **204** may have first surface **704** and second surface **706**. Both first surface **704** and second surface **706** may be substantially planar. In this manner, plate **204** may lie substantially flat on top of composite object **200**.

Turning now to **Figure 8**, an illustration of adhesive material that has been injected into composite object **200** is depicted in accordance with an illustrative embodiment. In this illustrative example, adhesive material **800** may be injected into opening **600** and opening **602** (not shown in this view) into composite object **200** through at least one of opening **700** and opening **702**, respectively, in plate **204**.

In one illustrative example, adhesive material **800** may be injected into opening **700** until adhesive material **800** squeezes out of opening **702**. Flange **318** and flange **320** (not shown in this view) from **Figure 3** may be used to prevent adhesive material **800** from escaping hollow portion **216** at edge **217** of composite object **200** before adhesive material **800** squeezes out of opening **702**.

As depicted, any excess of adhesive material **800** may spill over onto plate **204** without contacting first outer surface **212** of composite object **200** or first surface **305** of structure **218**.

In this manner, plate **204** may protect first outer surface **212** of composite object **200** and first surface **305** of structure **218** and reduce the amount of cleanup needed after insert **202** is bonded to composite object **200**.

With reference now to **Figure 9**, an illustration of insert **202** fully adhesively bonded to composite object **200** is depicted in accordance with an illustrative embodiment. In this illustrative example, plate **204** has been removed and adhesive material **800** has been allowed to harden.

Once adhesive material **800** hardens, insert **202** may be considered fully adhesively bonded to composite object **200**. Another fastener element (not shown), configured for association with another structure (not shown) may be attached to composite object **200** at edge **217** of composite object **200** using insert **202** and, in particular, fastener element **220** held within structure **218** of insert **202**.

Turning now to **Figure 10**, an illustration of an isometric view of a different configuration for an insert is depicted in accordance with an illustrative embodiment. In this illustrative example, insert **1000** may be an example of one implementation for insert **134** in **Figure 1**. As depicted, insert **1000** may include structure **1002**, fastener element **1004**, and cover **1006**.

With reference now to **Figure 11**, an illustration of an exploded isometric view of insert **1000** from **Figure 10** rotated about 180 degrees about axis **226** is depicted in accordance with an illustrative embodiment. As depicted, structure **1002** may have hollow fastener chamber **1100**. However, no other hollow chambers may be present within structure **1002** in this illustrative example.

Turning now to **Figure 12**, an illustration of an isometric view of a different configuration for an insert is depicted in accordance with an illustrative embodiment. In this illustrative example, insert **1200** may be an example of one implementation for insert **134** in **Figure 1**. As depicted, insert **1200** may include structure **1202**, fastener element **1204**, and cover **1206**.

With reference now to **Figure 13**, an illustration of an exploded isometric view of insert **1200** from **Figure 12** rotated about 180 degrees about axis **226** is depicted in accordance with an illustrative embodiment. In this illustrative example, structure **1202** may be configured to span a composite object (not shown) having a thickness that is greater than the thickness of composite object **200** in **Figure 2**.

As depicted, structure **1202** may have hollow fastener chamber **1300**. Further, structure **1202** may have hollow chamber **1302** and hollow chamber **1304**. Hollow chamber **1302** and hollow chamber **1304** may be longer than hollow chamber **502** and hollow chamber **504** in **Figure 5**.

The illustrations of composite object **200** in **Figure 2** and **Figures 6-9**, insert **202** in **Figures 2-9**, insert **1000** in **Figures 10-11**, and insert **1200** in **Figures 12-13** are not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to or in place of the ones illustrated may be used.

Some components may be optional.

Some of the components in **Figures 2-13** may be illustrative examples of how components shown in block form in **Figure 1** can be implemented as physical structures. The different components shown in **Figures 2-13** may be combined with components in **Figure 1**, used with components in **Figure 1**, or a combination of the two.

With reference now to **Figure 14**, an illustration of a process for associating an edge of a first object with a second object in the form of a flowchart is depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 14** may be implemented to, for example, without limitation, associate first object **102** with second object **104** using insert **134** in **Figure 1**.

The process begins by assembling the insert (operation **1400**). Operation **1400** may be performed by, for example, without

limitation, positioning a fastener element within a hollow fastener chamber of a structure and covering the fastener element and the hollow fastener chamber using a cover. The structure, the fastener element, and the cover may together form the insert.

Thereafter, the insert may be positioned within a hollow portion at the edge of the first object such that an edge surface of the structure is substantially even with the edge of the first object (operation **1402**). The hollow portion may span a total thickness of the first object. The structure may have a number of grooves configured to form a number of openings in the first object when the structure is inserted into the hollow portion of the structure.

Next, an adhesive material may be injected into the number of openings in the first object formed by the structure to adhesively bond the structure to the first object (operation **1404**). The second object may be attached to the edge of the first object using the fastener element held by the structure in the insert (operation **1406**), with the process terminating thereafter. In particular, the fastener element may be configured to receive another fastener element that is configured for association with the second object. In operation **1406**, the other fastener element may be installed within a channel extending through the fastener element held by the structure in the insert for use in attaching the second object to the first object.

The flowcharts and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations of apparatus and methods in different illustrative embodiments. In this regard, each block in the flowchart or block diagrams may represent a module, segment, function, and/or a portion of an operation or step.

In some alternative implementations, the function or functions noted in the block may occur out of the order noted in the figures. For example, without limitation, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. Also, other blocks may be added in addition to the illustrated blocks in a flowchart or block diagram.

Illustrative embodiments of the disclosure may be described in the context of aircraft manufacturing and service method **1500** as shown in **Figure 15** and aircraft **1600** as shown in **Figure 16**. Turning first to **Figure 15**, an illustration of an aircraft manufacturing and service method in the form of a block diagram is depicted in accordance with an illustrative embodiment.

During pre-production, aircraft manufacturing and service method **1500** may include specification and design **1502** of aircraft **1600** in **Figure 16** and material procurement **1504**.

During production, component and subassembly manufacturing **1506** and system integration **1508** of aircraft **1600** in **Figure 16** takes place. Thereafter, aircraft **1600** in **Figure 16** may go through certification and delivery **1510** in order to be placed in service **1512**. While in service **1512** by a customer, aircraft **1600** in **Figure 16** is scheduled for routine maintenance and service **1514**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

Each of the processes of aircraft manufacturing and service method **1500** may be performed or carried out by a system integrator, a third party, and/or an operator. In these examples, the operator may be a customer. For the purposes of this description, a system integrator may include, without limitation, any number of aircraft manufacturers and major-system subcontractors; a third party may include, without limitation, any number of vendors, subcontractors, and

suppliers; and an operator may be an airline, a leasing company, a military entity, a service organization, and so on.

With reference now to **Figure 16**, an illustration of an aircraft in the form of a block diagram is depicted in which an illustrative embodiment may be implemented. In this example, aircraft **1600** is produced by aircraft manufacturing and service method **1500** in **Figure 15** and may include airframe **1602** with plurality of systems **1604** and interior **1606**. Examples of systems **1604** include one or more of propulsion system **1608**, electrical system **1610**, hydraulic system **1612**, and environmental system **1614**. Any number of other systems may be included. Although an aerospace example is shown, different illustrative embodiments may be applied to other industries, such as the automotive industry.

Apparatuses and methods embodied herein may be employed during at least one of the stages of aircraft manufacturing and service method **1500** in **Figure 15**. Any number of inserts, implemented in a manner similar to insert **134** in **Figure 1**, may be used to associate structures with the edges of other structures and, in particular, composite objects. Insert **134** may be configured for use during any one or more of, for example, without limitation, production, component and subassembly manufacturing **1506**, system integration **1508**, in service **1512**, routine maintenance and service **1514**, and other stages that may be part of aircraft manufacturing and service method **1500**.

In one illustrative example, components or subassemblies produced in component and subassembly manufacturing **1506** in **Figure 15** may be fabricated or manufactured in a manner similar to components or subassemblies produced while aircraft **1600** is in service **1512** in **Figure 15**. As yet another example, one or more apparatus embodiments, method embodiments, or a combination thereof may be utilized during production stages, such as component and subassembly manufacturing **1506** and system

integration **1508** in **Figure 15**. One or more apparatus
embodiments, method embodiments, or a combination thereof may be
utilized while aircraft **1600** is in service **1512** and/or during
maintenance and service **1514** in **Figure 15**. The use of a number
5 of the different illustrative embodiments may substantially
expedite the assembly of and/or reduce the cost of aircraft **1600**.

The description of the different illustrative embodiments
has been presented for purposes of illustration and description,
and is not intended to be exhaustive or limited to the
10 embodiments in the form disclosed. Many modifications and
variations will be apparent to those of ordinary skill in the
art. Further, different illustrative embodiments may provide
different features as compared to other illustrative
embodiments. The embodiment or embodiments selected are chosen
15 and described in order to best explain the principles of the
embodiments, the practical application, and to enable others of
ordinary skill in the art to understand the disclosure for
various embodiments with various modifications as are suited to
the particular use contemplated.

CLAIMS:

What is claimed is:

- 5 1. An apparatus comprising:
a fastener element; and
a structure configured to hold the fastener element such
that the fastener element is exposed at an edge of an object
when the structure is inserted within a hollow portion of the
10 object at the edge of the object in which the structure is
configured to span an entire thickness of the object at the edge
of the object.
2. The apparatus of claim 1, wherein the structure comprises:
15 a hollow fastener chamber configured to receive and hold
the fastener element.
3. The apparatus of claim 2 further comprising:
a cover configured to cover the fastener element and the
20 hollow fastener chamber of the structure.
4. The apparatus of claim 3, wherein the structure, the
fastener element, and the cover form an insert.
- 25 5. The apparatus of claim 2, wherein the hollow fastener
chamber of the structure has a first size that is greater than a
second size of the fastener element such that the fastener
element is allowed to move freely within the hollow fastener
chamber of the structure within a plane substantially
30 perpendicular to an axis through the fastener element.
6. The apparatus of claim 1, wherein the structure comprises:
a set of hollow chambers configured to reduce a weight of
the structure.

7. The apparatus of claim 1, wherein the structure comprises:
a number of grooves configured for use in forming a number
of openings in the object when the structure is inserted into
the hollow portion of the object.

8. The apparatus of claim 7, wherein an adhesive material is
configured to be injected into the number of openings to
adhesively bond the structure to the object.

9. The apparatus of claim 1 further comprising:
a number of flanges associated with the structure, wherein
a flange in the number of flanges is flexible at an interface
between the flange and the structure.

10. The apparatus of claim 1, wherein the structure comprises:
an edge surface configured to be substantially even with
the edge of the object when the structure is inserted into the
hollow portion of the object;

a first surface configured to be substantially even with a
first outer surface of the object; and

a second surface configured to be substantially even with a
second outer surface of the object.

11. The apparatus of claim 10, wherein the edge surface has an
opening that allows a channel extending through the fastener
element to be at least partially exposed at the edge of the
object.

12. The apparatus of claim 1, wherein the object is a composite
object comprising:

a first layer;

a second layer; and

a core located between the first layer and the second layer in which the core is selected from one of a honeycomb core and a foam core.

13. The apparatus of claim 1, wherein the object is a first object and wherein the fastener element is configured to receive a corresponding fastener element configured for association with a second object and configured for use in attaching the second object to the first object.

14. An insert configured for use at an edge of an object, the insert comprising:

a fastener element;

a structure configured to be inserted within a hollow portion at the edge of the object in which the structure is configured to span an entire thickness of the object at the edge of the object, wherein the structure comprises:

a hollow fastener chamber configured to receive and hold the fastener element such that the fastener element is exposed at the edge of the object when the insert is inserted within the hollow portion of the object in which the hollow fastener chamber has a first size that is greater than a second size of the fastener element such that the fastener element is allowed to move freely within the hollow fastener chamber of the structure within a plane substantially perpendicular to an axis through the fastener element;

a set of hollow chambers configured to reduce a weight of the structure;

an edge surface configured to be substantially even with the edge of the object when the structure is inserted into the hollow portion of the object;

a first surface configured to be substantially even with a first outer surface of the object;

a second surface configured to be substantially even with a second outer surface of the object; and

a number of grooves configured to form a number of openings in the object when the structure is inserted into the hollow portion of the object in which an adhesive material is configured to be injected into the number of openings to adhesively bond the structure to the object; and

a cover configured to cover the fastener element and the hollow fastener chamber of the structure.

15. A method for associating an edge of a first object with a second object, the method comprising:

positioning an insert comprising a structure holding a fastener element within a hollow portion at the edge of the first object such that the fastener element is exposed at the edge of the first object in which the structure is configured to span an entire thickness of the first object at the edge of the first object;

adhesively bonding the structure to the first object; and attaching the second object to the edge of the first object using the fastener element.

16. The method of claim 15 further comprising:

assembling the insert.

17. The method of claim 16, wherein assembling the insert comprises:

positioning the fastener element within a hollow fastener chamber of the structure; and

covering the fastener element and the hollow fastener chamber using a cover, wherein the structure, the fastener element, and the cover form the insert.

18. The method of claim 15, wherein positioning the insert comprising the structure holding the fastener element within the hollow portion comprises:

5 inserting the structure holding the fastener element into the hollow portion such that an edge surface of the structure is substantially even with the edge of the first object.

19. The method of claim 18, wherein inserting the structure holding the fastener element into the hollow portion such that the edge surface of the structure is substantially even with the edge of the first object comprises:

15 inserting the structure holding the fastener element into the hollow portion such that the edge surface of the structure is substantially even with the edge of the first object, wherein the structure has a number of grooves configured to form a number of openings in the first object when the structure is inserted into the hollow portion of the first object.

20. The method of claim 19, wherein adhesively bonding the structure to the first object comprises:

injecting an adhesive material into the number of openings in the first object to adhesively bond the structure to the first object.

25 21. The method of claim 15, wherein attaching the second object to the edge of the first object using the fastener element comprises:

30 installing a corresponding fastener element configured for association with the second object within a channel extending through the fastener element at the edge of the first object for use in attaching the second object to the first object.

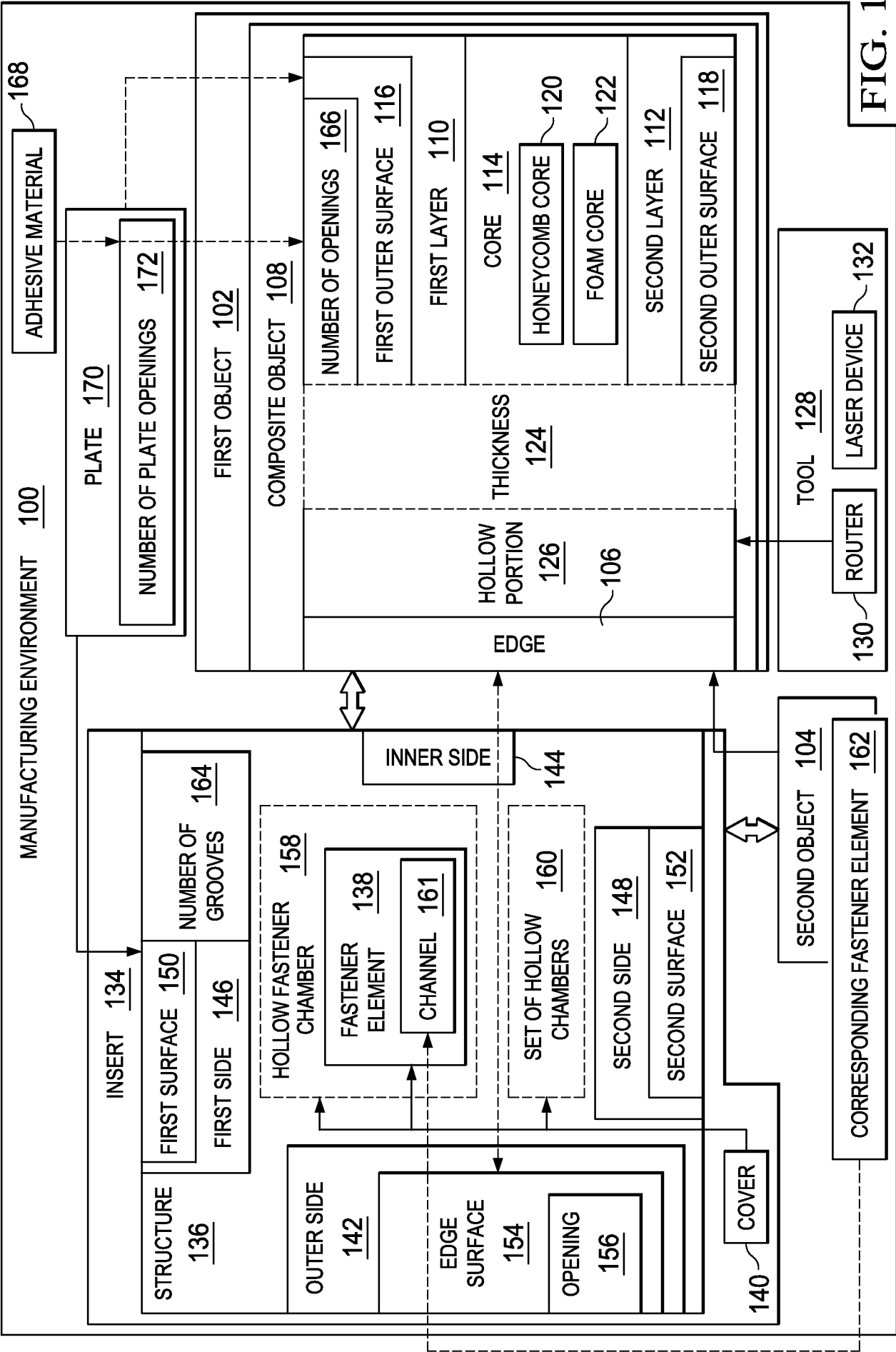
22. A method for associating an edge of a first object with a second object, the method comprising:

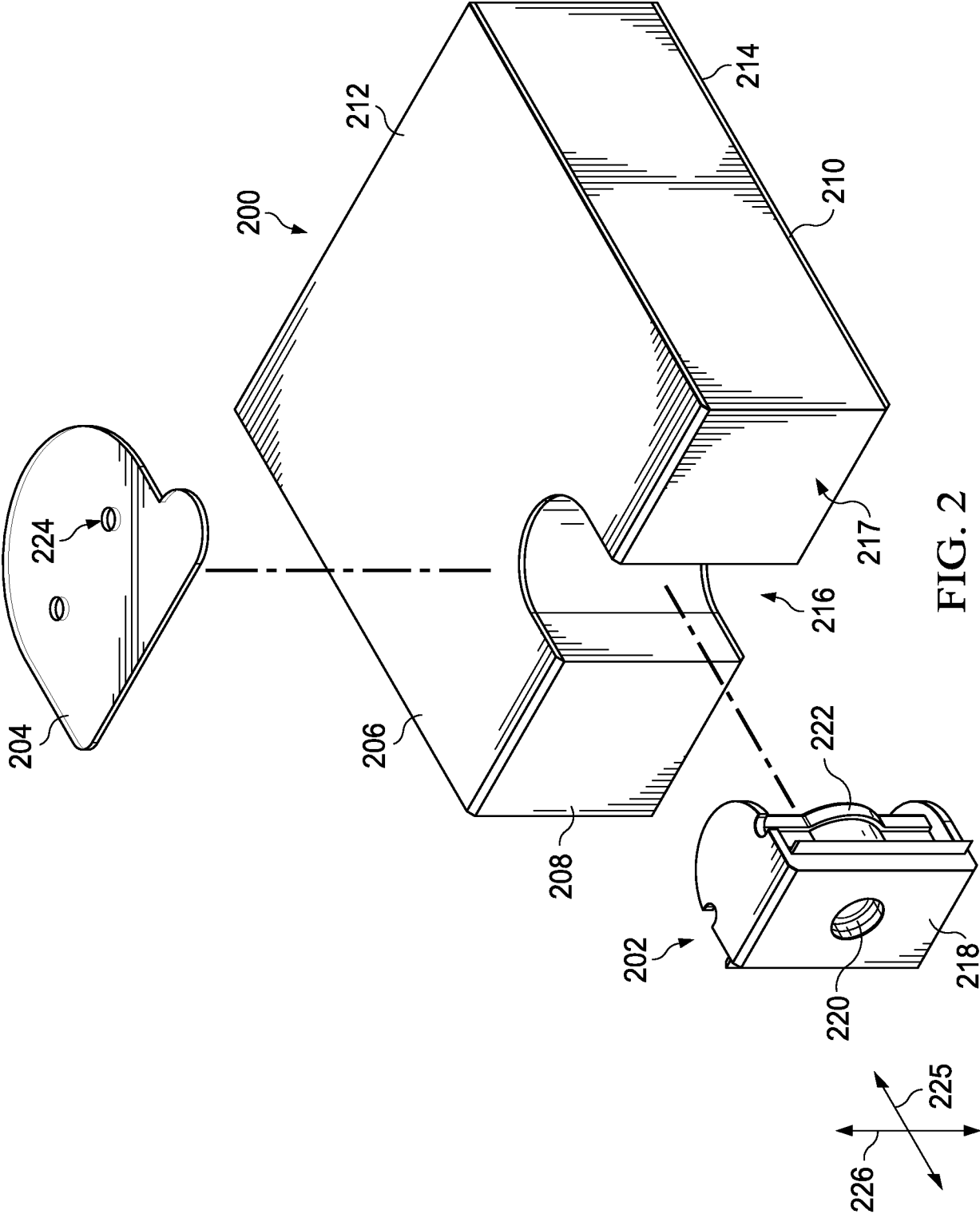
assembling an insert by positioning a fastener element within a hollow fastener chamber of a structure and covering the fastener element and the hollow fastener chamber using a cover;

5 positioning the insert within a hollow portion at the edge of the first object such that an edge surface of the structure is substantially even with the edge of the first object and such that the fastener element is exposed at the edge of the object in which the structure is configured to span an entire thickness of the first object at the edge of the first object and in which
10 the structure has a number of grooves configured to form a number of openings in the first object when the structure is inserted into the hollow portion of the first object;

injecting an adhesive material into the number of openings in the first object to adhesively bond the structure to the
15 first object; and

attaching the second object to the edge of the first object using a corresponding fastener element configured for association with the second object within a channel extending through the fastener element held by the structure in the
20 insert.





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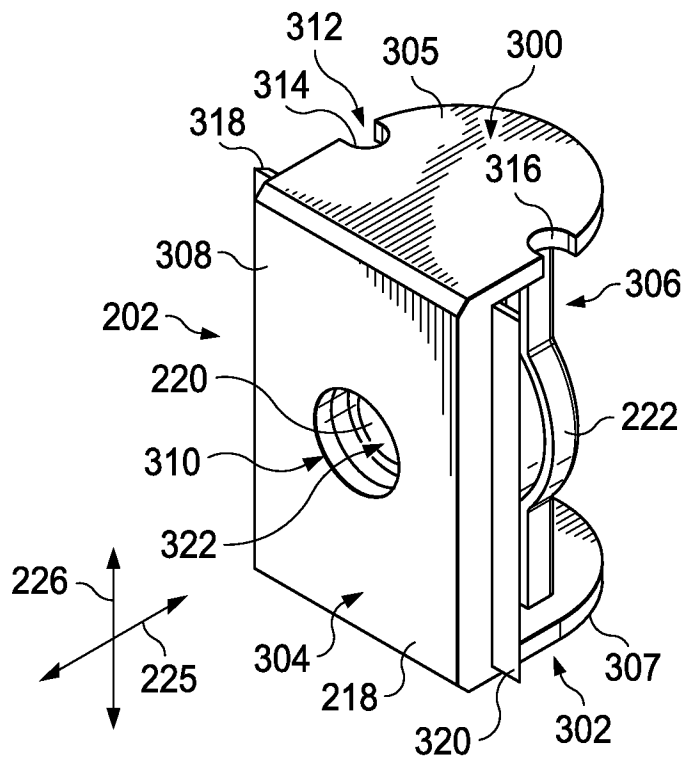


FIG. 3

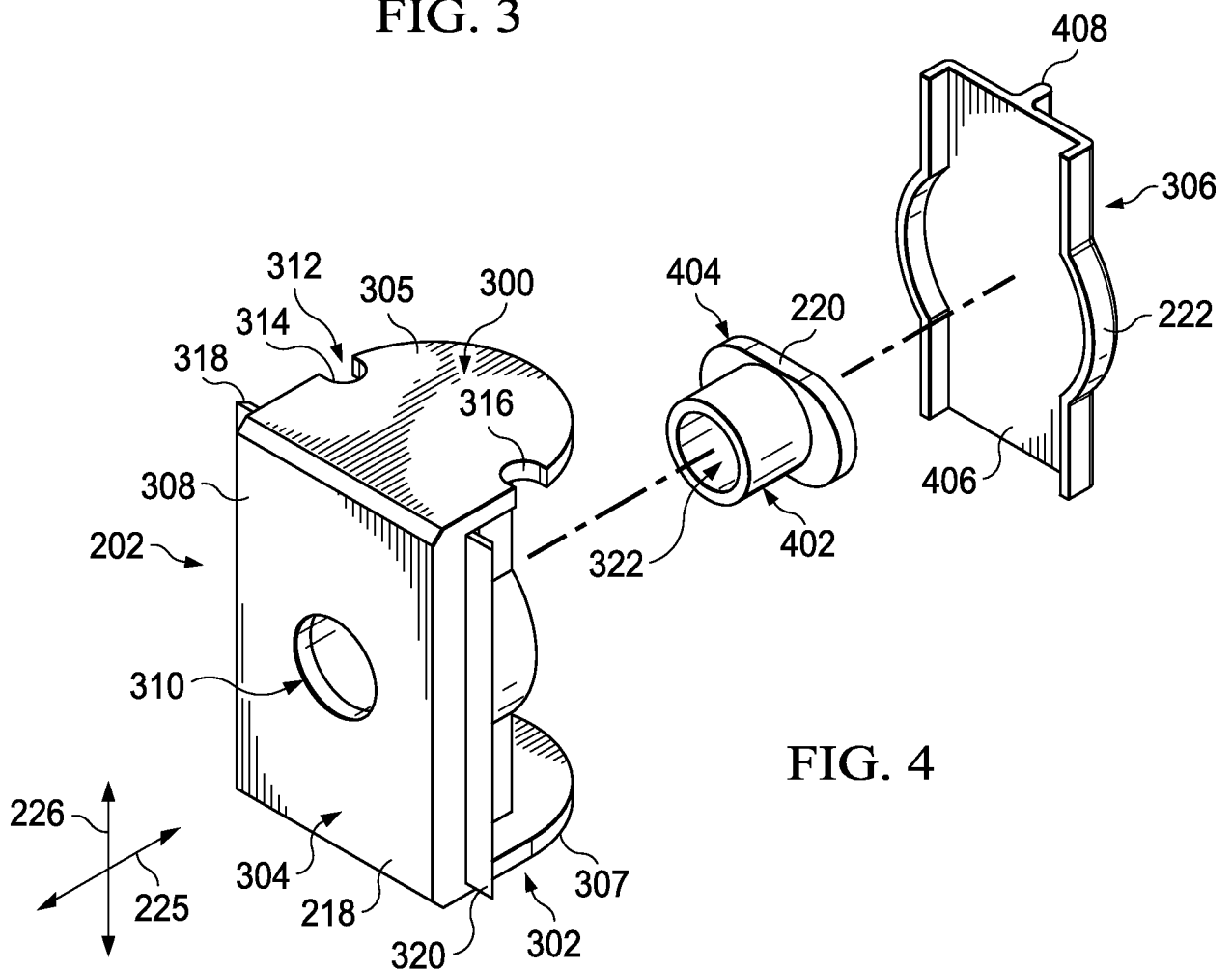
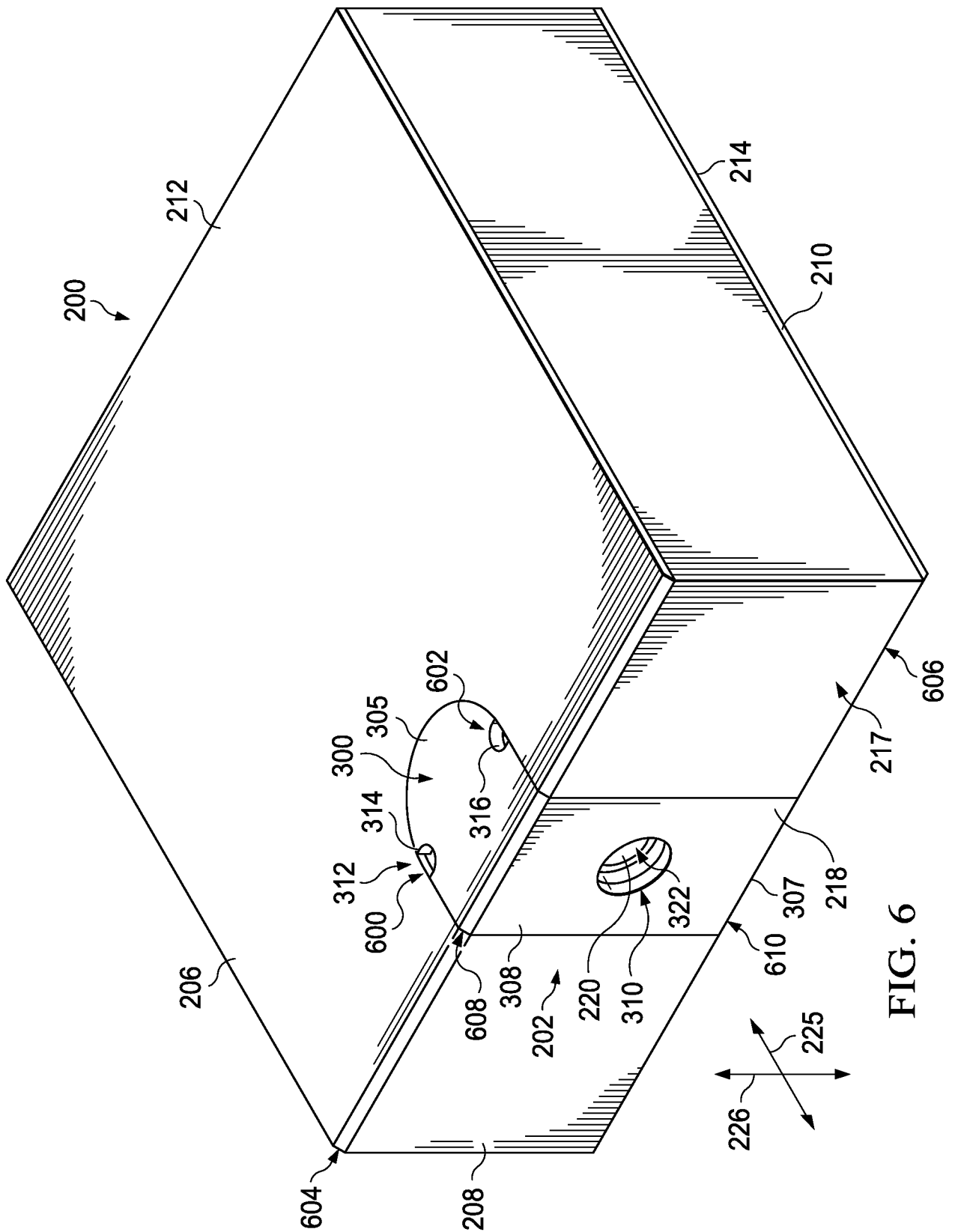


FIG. 4



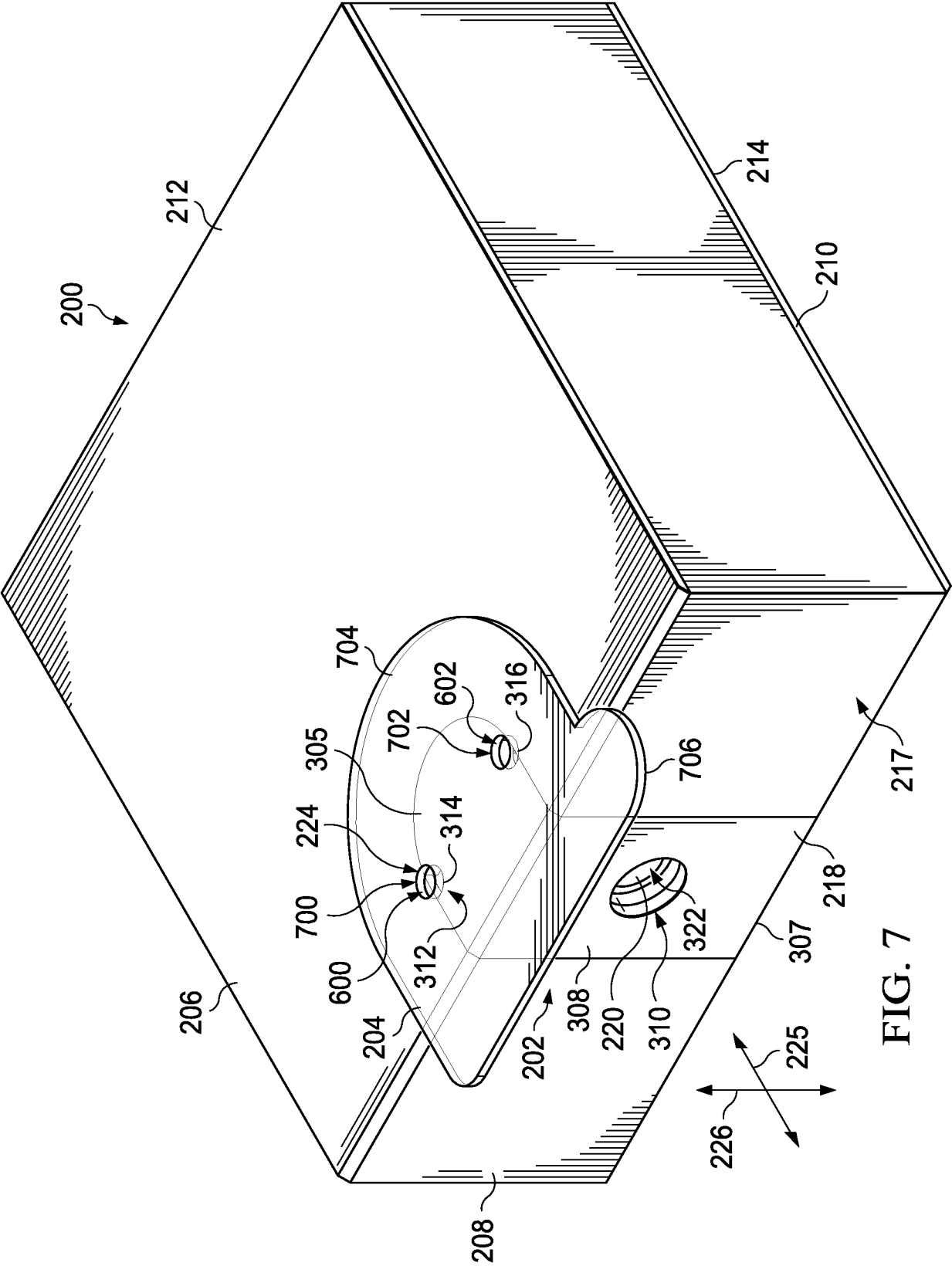


FIG. 7

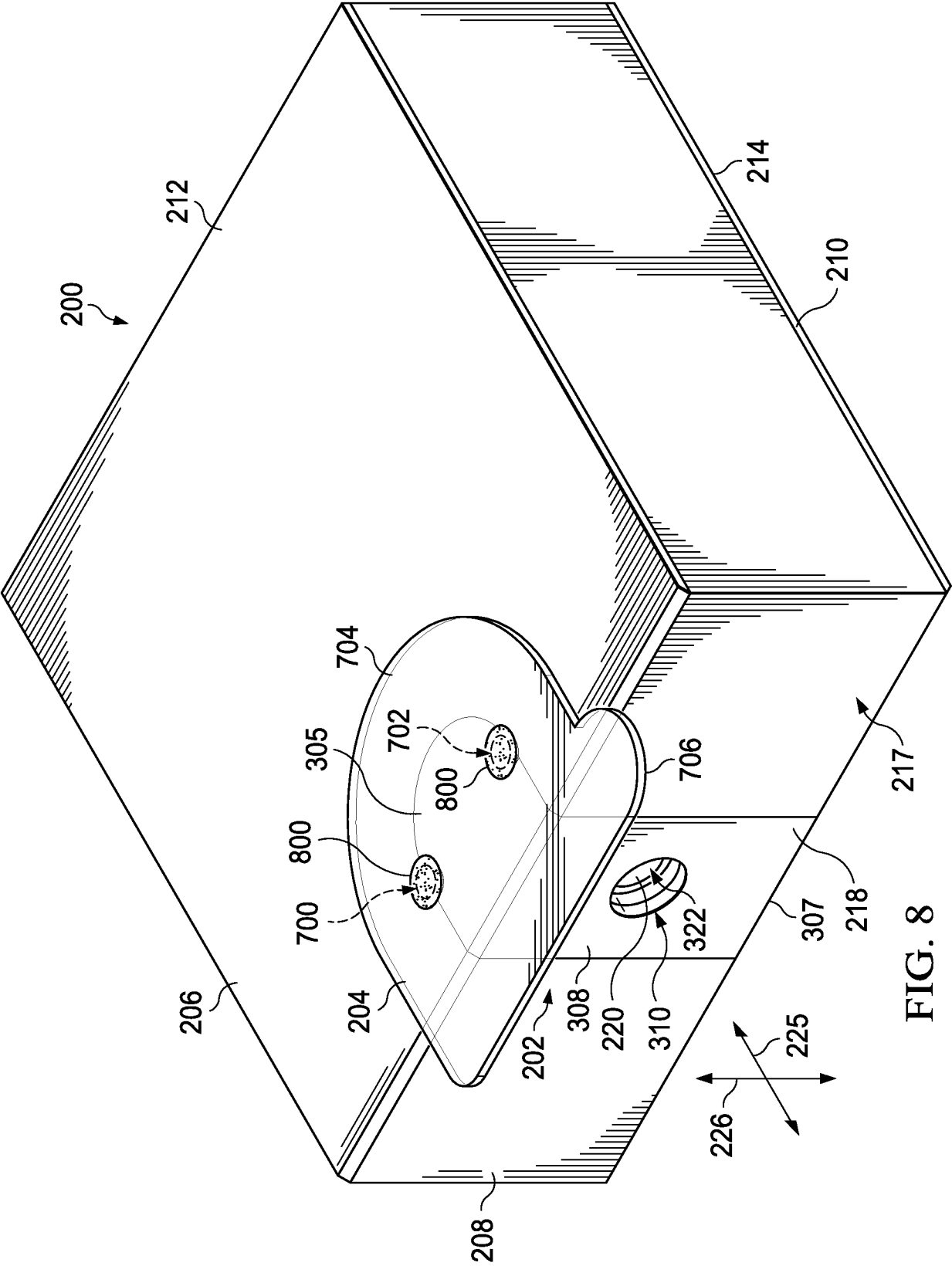


FIG. 8

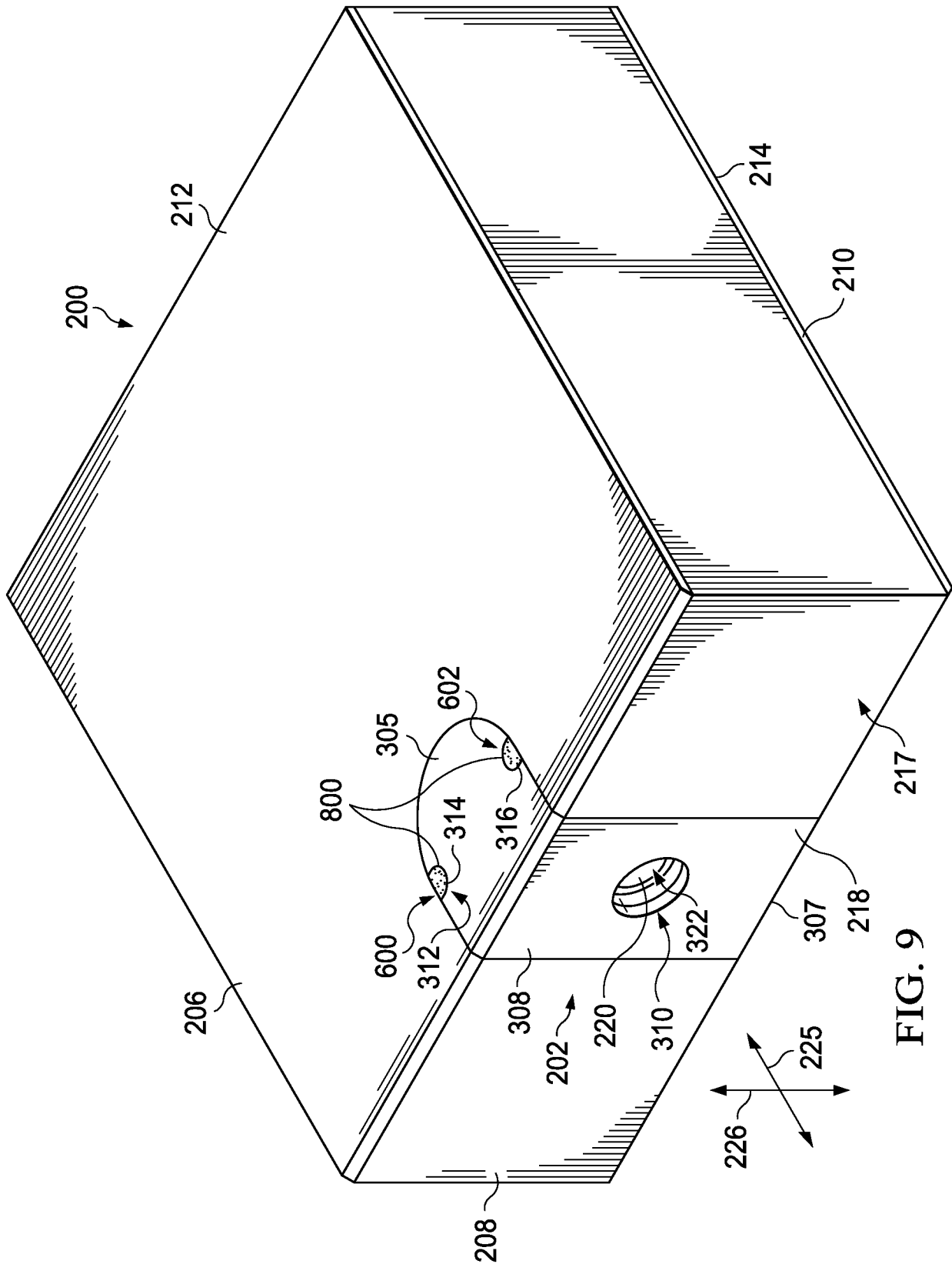
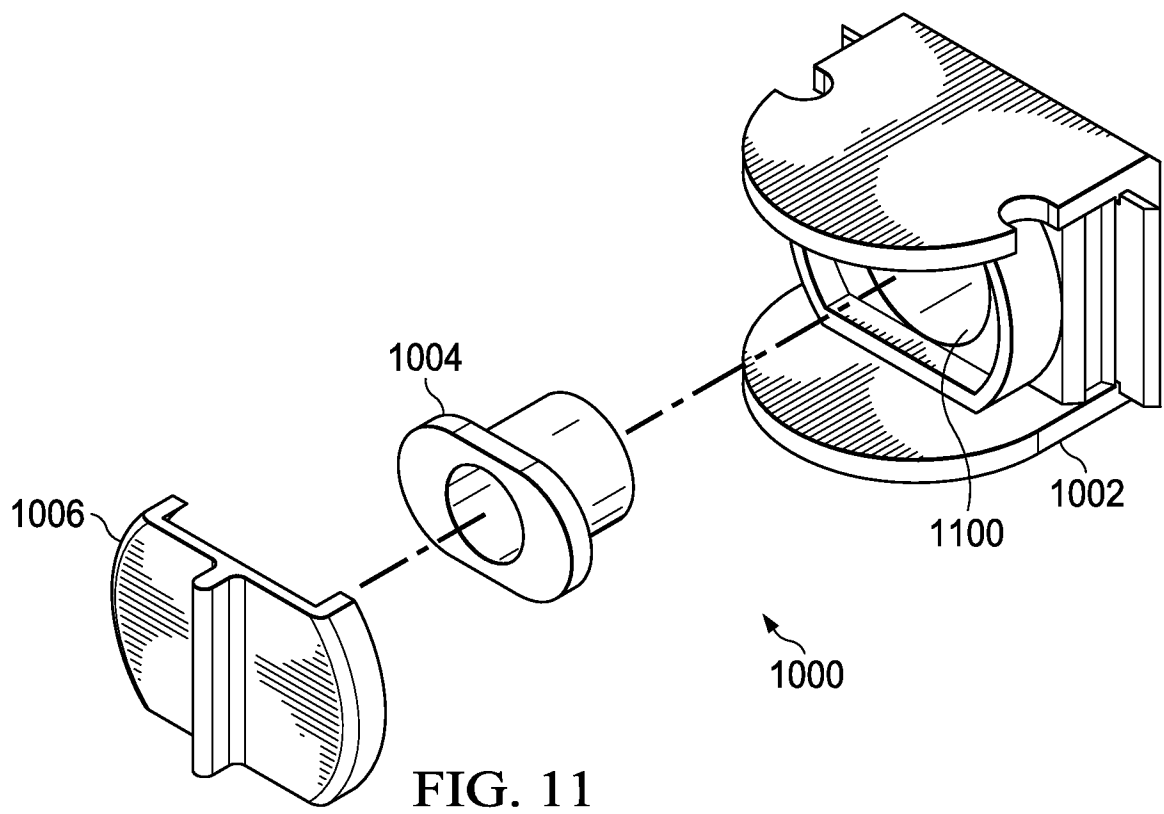
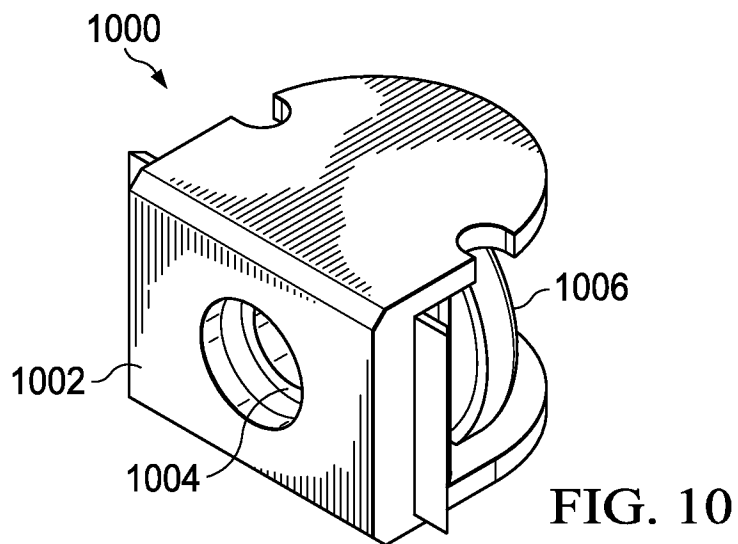
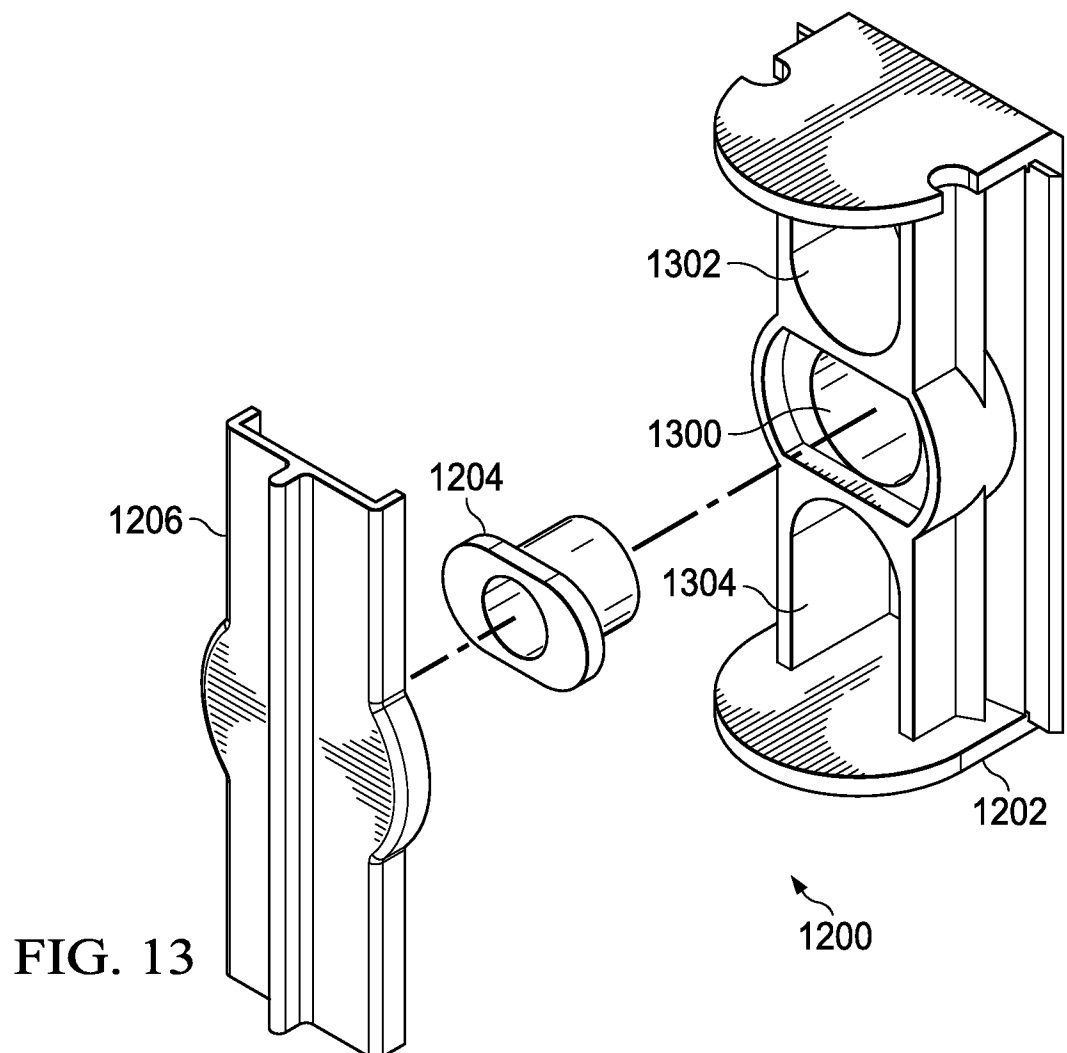
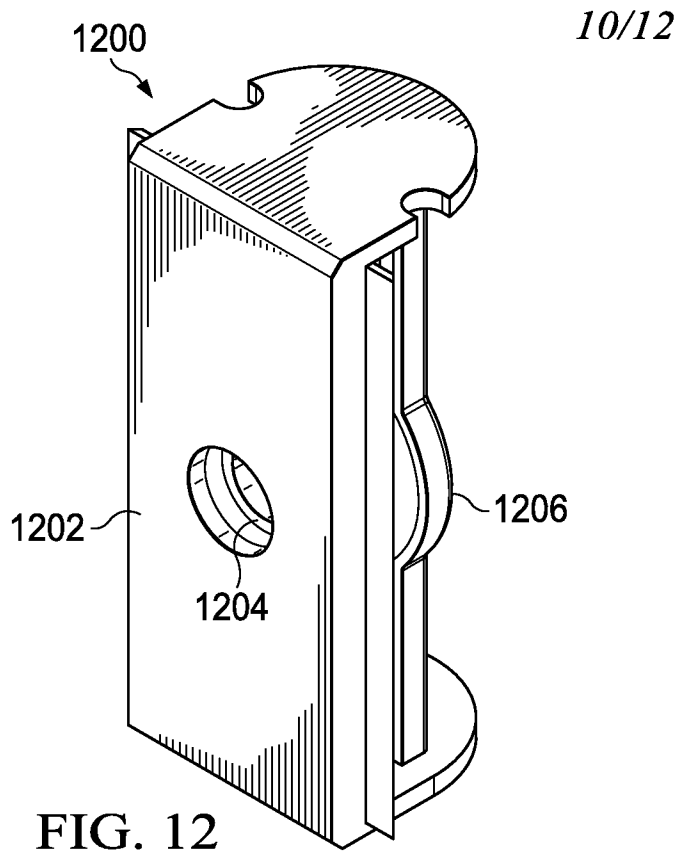


FIG. 9

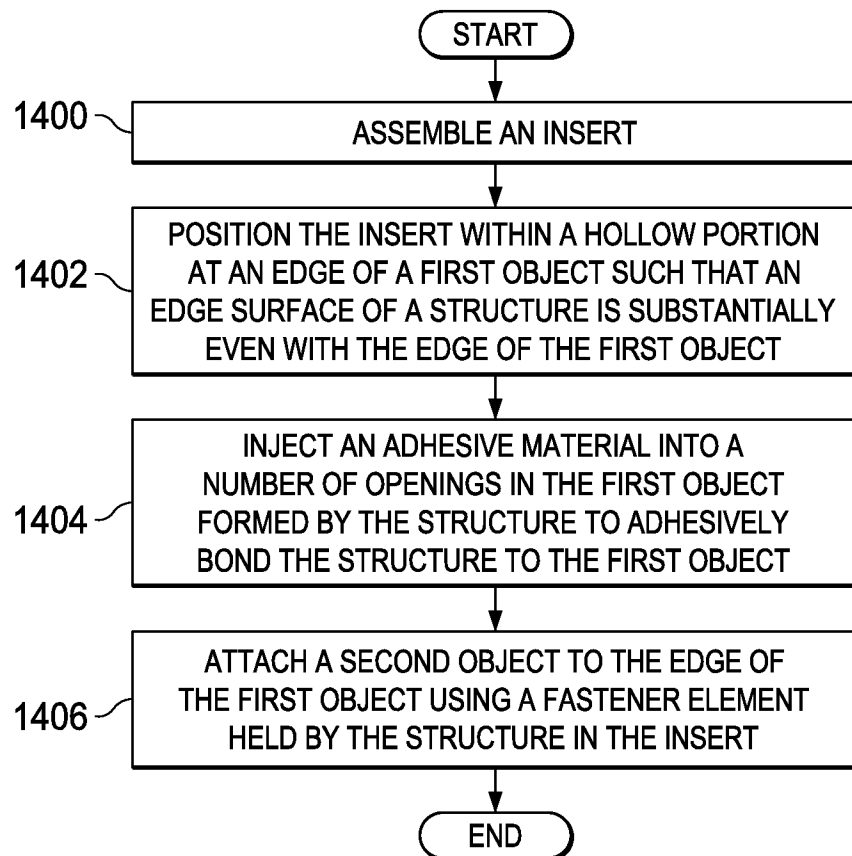
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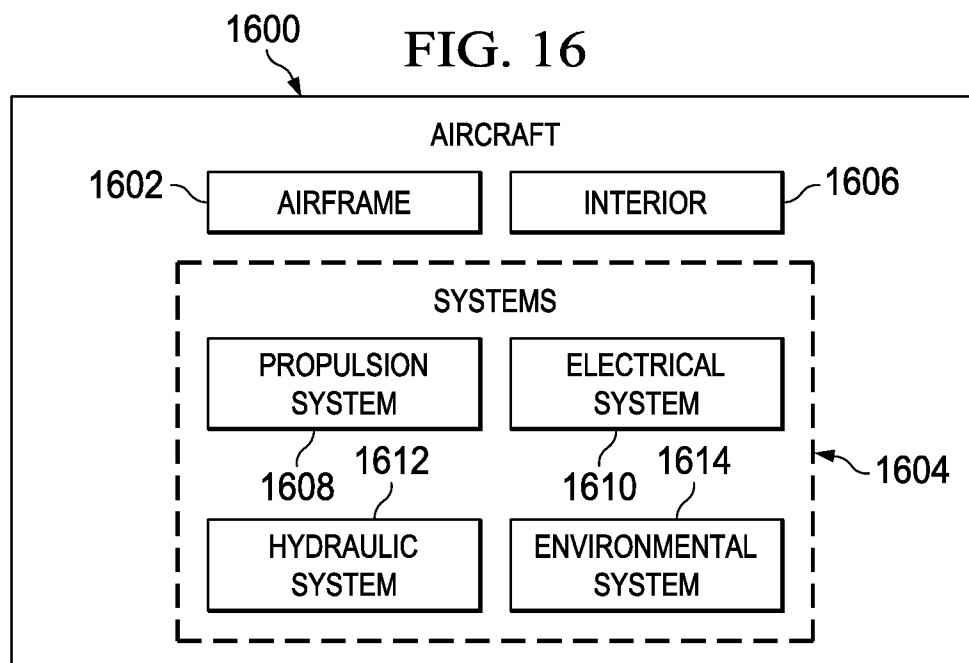
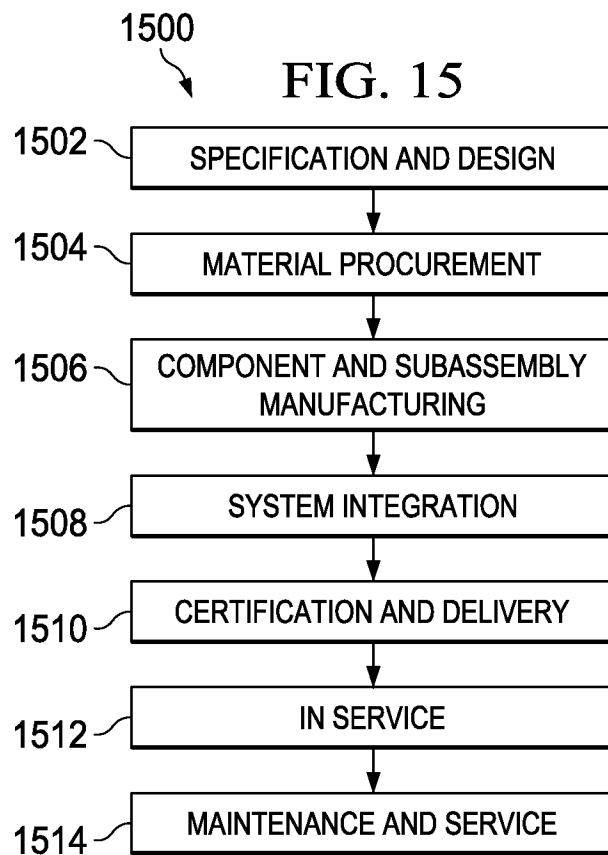


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FIG. 14



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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/076793

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16B5/01
ADD.

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)
F16B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2005 057525 B3 (EIERLE BENNO [DE]) 6 June 2007 (2007-06-06) paragraph [0021] - paragraph [0030]; figures 1,2	1-22
X	----- EP 0 359 602 A1 (AEROSPATIALE [FR]) 21 March 1990 (1990-03-21) column 4, line 10 - column 6, line 4; figures 1-3	1-22
X	----- US 5 324 146 A (PARENTI ROBERT V [US] ET AL) 28 June 1994 (1994-06-28) column 1, line 35 - column 6, line 17; figures 1a,2a,3a, -----	1-22



Further documents are listed in the continuation of Box C.



See patent family annex.

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"E" earlier application or patent but published on or after the international filing date

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"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

15 April 2014

Date of mailing of the international search report

28/04/2014

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Fax: (+31-70) 340-3016

Authorized officer

Comel, Ezio

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/076793

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