(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 524 508 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.08.2019 Bulletin 2019/33

(51) Int Cl.:
B64C 1/14 *(2006.01)*

(21) Application number: **18248071.5**

(22) Date of filing: **27.12.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **02.02.2018 US 201815887898**

(71) Applicant: **The Boeing Company**
Chicago, IL 60606-1596 (US)

(72) Inventors:
- **Young, Stephen M.**
  Chicago, IL 60606-1596 (US)
- **Turner, Jason**
  Chicago, IL 60606-1596 (US)
- **Swanson, Kevin G.**
  Chicago, IL 60606-1596 (US)
- **Egging, Duane M.**
  Chicago, IL 60606-1596 (US)

(74) Representative: **Duxbury, Stephen**
Arnold & Siedsma
Bavariaring 17
80336 München (DE)

(54) HINGED COMPOSITE SANDWICH PANELS

(57) An apparatus comprises a composite sandwich panel (100), a seal (110), and a hinge (112). The composite sandwich panel has a first edge (104) in a first over-crush edge region (106), wherein a thickness (108) of the composite sandwich panel decreases within the first over-crush edge region in a direction towards the first edge. The seal is bonded to the first over-crush edge region of the composite sandwich panel and extending past the first edge. The hinge is connected to the composite sandwich panel such that an axis of rotation (114) of the hinge is positioned over the first over-crush edge region of the composite sandwich panel.

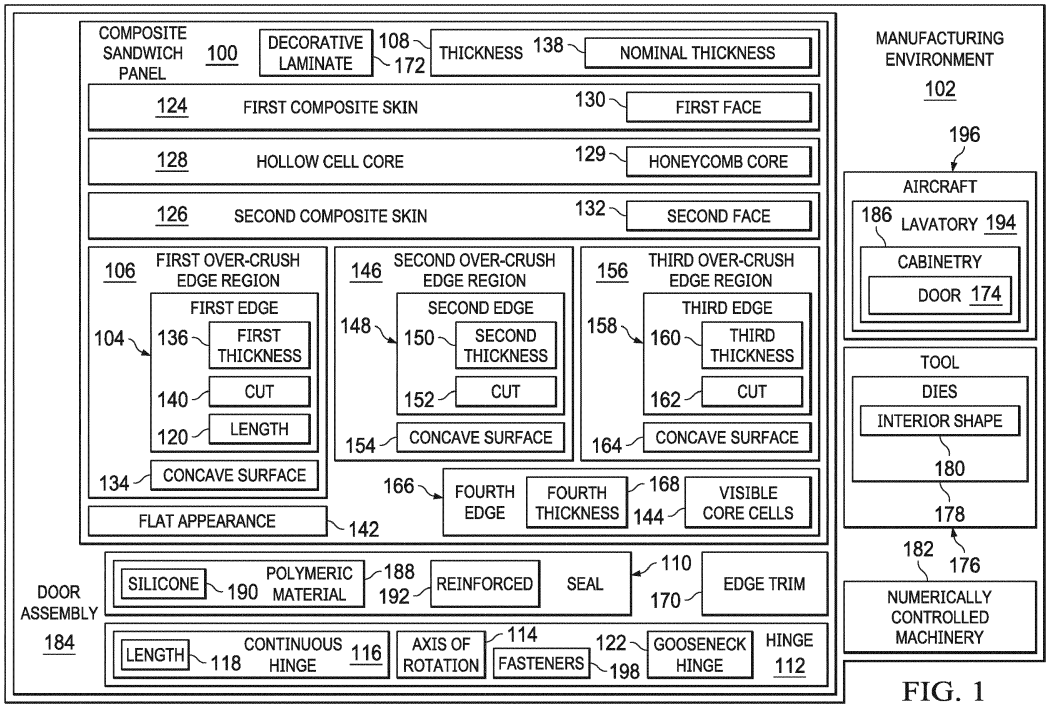

FIG. 1

EP 3 524 508 A1

Description

BACKGROUND INFORMATION

1. Field:

[0001] The present disclosure relates generally to cabinetry doors and, more specifically, to forming cabinetry doors using composite sandwich panels.

2. Background:

[0002] Today, cabinetry inside aircraft lavatories is typically formed of either injection-molded or thermoformed plastics. These injection-molded or thermoformed plastics are usually painted in solid colors. Cabinetry inside aircraft lavatories is visible and accessible to passengers within the aircraft.

[0003] Cabinetry in aircraft lavatories is desirably accessed only by aircraft personnel. Cabinetry in aircraft lavatories desirably contains consistent, tight gaps between cabinetry panels. Consistent, tight gaps between cabinetry panels create a desirable decorative appearance. Consistent, tight gaps between cabinetry panels may reduce visibility of doors in cabinetry to passengers.

[0004] Commercial aircraft are in service for decades. During the course of an aircraft's lifetime, components are replaced during maintenance due to wear or replacement schedules.

[0005] Therefore, it would be desirable to have a method and apparatus that take into account at least some of the issues discussed above, as well as other possible issues. It would be desirable to have an improved ability to customize the decorative face of aircraft lavatory cabinets. It would also be desirable to reduce frequency of replacement of components of aircraft lavatory cabinetry.

SUMMARY

[0006] The present disclosure provides an apparatus. The apparatus comprises a composite sandwich panel, a seal, and a hinge. The composite sandwich panel has a first edge in a first over-crush edge region, wherein a thickness of the composite sandwich panel decreases within the first over-crush edge region in a direction towards the first edge. The seal is bonded to the first over-crush edge region of the composite sandwich panel and extending past the first edge. The hinge is connected to the composite sandwich panel such that an axis of rotation of the hinge is positioned over the first over-crush edge region of the composite sandwich panel.

[0007] The present disclosure also provides a method. A seal is bonded to a first over-crush edge region of a composite sandwich panel, wherein a thickness of the composite sandwich panel decreases within the first over-crush edge region in a direction towards a first edge of the composite sandwich panel within the first over-crush edge region. A hinge is connected to the first over-crush edge region of the composite sandwich panel.

[0008] The present disclosure also provides an apparatus. The apparatus comprises a composite sandwich panel, a panel, and a hinge. The composite sandwich panel has a cut first edge, a cut second edge, and a cut third edge each with a flat appearance without visible core cells. The seal is bonded to the composite sandwich panel adjacent the cut first edge. The hinge is connected to the composite sandwich panel adjacent the cut first edge.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figure 1 is an illustration of a block diagram of a manufacturing environment in which composite sandwich panels are used to form a door in accordance with the present disclosure;

Figure 2 is an illustration of a front view of a lavatory cabinetry with a door formed of a composite sandwich panel in accordance with the present disclosure;

Figure 3 is an illustration of a back view of a lavatory cabinetry with a door formed of a composite sandwich panel in accordance with the present disclosure;

Figure 4 is an illustration of a front isometric view of a composite sandwich panel in accordance with the present disclosure;

Figure 5 is an illustration of a back isometric view of a composite sandwich panel in accordance with an illustrative embodiment;

Figure 6 is an illustration of a front isometric view of a composite sandwich panel with a seal in accordance with the present disclosure;

Figure 7 is an illustration of a front isometric view of a composite sandwich panel with a seal and a hinge in accordance with the present disclosure;

Figure 8 is an illustration of a side view of a composite sandwich panel in accordance with the present disclosure;

Figure 9 is an illustration of a side view of a composite sandwich panel with a seal in accordance with the present disclosure;

Figure 10 is an illustration of a side view of a composite sandwich panel with a seal and a hinge in accordance with the present disclosure;

Figure 11 is another illustration of a side view of a composite sandwich panel with a seal and a hinge in accordance with the present disclosure;

Figure 12 is an illustration of a side view of a composite sandwich panel with a seal and a hinge installed in cabinetry and in a closed position in accordance with the present disclosure;

Figure 13 is an illustration of a side view of a composite sandwich panel with a seal and a hinge installed in cabinetry and in an open position in ac-

cordance with the present disclosure;

Figure 14 is an illustration of a flowchart of a method for forming and using a composite sandwich panel in accordance with the present disclosure;

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

Figure 16 is an illustration of an aircraft in the form of a block diagram in which the present disclosure; may be implemented.

DETAILED DESCRIPTION

[0010] The present disclosure recognizes and take into account one or more different considerations. For example, the present disclosure recognizes and takes into account that it is desirable to create cabinetry doors with greater durability to decrease replacement frequency. The present disclosure recognizes and takes into account that it is desirable to increase the strength of the doors of aircraft lavatory cabinetry. The present disclosure recognizes and takes into account that it is desirable to decrease the weight of aircraft components. The present disclosure recognizes and takes into account that it is desirable to maintain straight, tight gaps between door panels in lavatory cabinetry. The present disclosure recognizes and takes into account that it is desirable to prevent sagging doors in order to maintain straight, tight gaps between door panels in lavatory cabinetry.

[0011] The present disclosure recognizea and takes into account that composite sandwich panels have a high strength to weight ratio. The present disclosure recognizes and takes into account that to form composite sandwich panels, composite skins are compressed against a hollow cell core. The present disclosure recognizes and takes into account that conventionally, it is desirable to prevent over-crush of the hollow cell core.

[0012] The present disclosure s recognizes and takes into account that cut edges of composite sandwich panels have visible core cells. The present disclosure recognizes and takes into account that edge trim may be applied to cut edges of composite sandwich panels to cover the visible core cells. The present disclosure recognizes and takes into account that the edge trim is not considered desirably decorative or desirably durable by aircraft customers. The present disclosure recognizes and takes into account that the edge trim may cause doors in lavatory cabinetry to be undesirably visible to passengers. The present disclosure recognizes and takes into account that the presence of edge trims may call a passenger's attention to the fact that there is a door present. The present disclosure recognizes and takes into account that it is desirable for doors to remain effectively disguised from passengers.

[0013] The present disclosure recognizes and takes into account that the thickness of an edge of a composite sandwich panel affects the size of gaps in lavatory cabinetry. The present disclosure recognizes and takes into account that increasing the thickness of an edge of a composite sandwich panel increases the size of the gaps in the lavatory cabinetry.

[0014] The present disclosure presents an apparatus and method for forming a door comprising a composite sandwich panel. The present disclosure presents an apparatus comprising a composite sandwich panel, a seal, and a hinge. The composite sandwich panel has a first edge in a first over-crush edge region, wherein a thickness of the composite sandwich panel decreases within the first over-crush edge region in a direction towards the first edge. The seal is bonded to the first over-crush edge region of the composite sandwich panel and extending past the first edge. The hinge is connected to the composite sandwich panel such that an axis of rotation of the hinge is positioned over the first over-crush edge region of the composite sandwich panel.

[0015] Referring now to the figures and, in particular, with reference to **Figure 1**, an illustration of a block diagram of a manufacturing environment in which composite sandwich panels are used to form a door is depicted in accordance with the present disclosure. Composite sandwich panel **100** in manufacturing environment **102** has first edge **104** in first over-crush edge region **106**. Thickness **108** of composite sandwich panel **100** decreases within first over-crush edge region **106** in a direction towards first edge **104**.

[0016] Seal **110** is bonded to first over-crush edge region **106** of composite sandwich panel **100**. Seal **110** extends past first edge **104**.

[0017] Hinge **112** is connected to composite sandwich panel **100** such that axis of rotation **114** of hinge **112** is positioned over first over-crush edge region **106** of composite sandwich panel **100**.

[0018] In some illustrative examples, seal **110** ends before reaching hinge **112**. In some illustrative examples, a portion of seal **110** is sandwiched between hinge **112** and composite sandwich panel **100**.

[0019] In some illustrative examples, hinge **112** is continuous hinge **116**. Continuous hinge **116** may also be referred to as a "piano hinge." In some illustrative examples, continuous hinge **116** has length **118** equivalent to length **120** of first edge **104**. In some illustrative examples, hinge **112** is gooseneck hinge **122**.

[0020] Composite sandwich panel **100** comprises first composite skin **124**, second composite skin **126**, and hollow cell core **128** between first composite skin **124** and second composite skin **126**. First composite skin **124** and second composite skin **126** are compressed against hollow cell core **128** to form composite sandwich panel **100**. In some illustrative examples, hollow cell core **128** takes the form of honeycomb core **129**. In some illustrative examples, hollow cell core **128** is corrugated as shown in **Figure 5**.

[0021] Composite sandwich panel **100** has first face **130** and second face **132** opposite first face **130**. First face **130** is part of first composite skin **124**. Second face **132** is part of second composite skin **126**.

[0022] In some illustrative examples, second face **132** has concave surface **134** within first over-crush edge region **106**. Concave surface **134** may have any desirable shape. In some illustrative examples, concave surface **134** is curved. In some illustrative examples, concave surface **134** is a ramp. In some illustrative examples, concave surface **134** is a combination of straight and curved sections.

[0023] First edge **104** of first over-crush edge region **106** has first thickness **136**. First thickness **136** is less than nominal thickness **138** of composite sandwich panel **100**. Nominal thickness **138** is thickness **108** of composite sandwich panel **100** after consolidation of first composite skin **124**, hollow cell core **128**, and second composite skin **126** to form composite sandwich panel **100**. First thickness **136** is in the range of 40%-15% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, first thickness **136** is in the range of 30%-20% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, first thickness **136** has an 80% over-crush. In these illustrative examples, first thickness **136** is approximately 20% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, nominal thickness **138** may be referred to as an "uncrushed thickness."

[0024] First edge **104** is cut **140**. Portions of first composite skin **124**, hollow cell core **128**, and second composite skin **126** are visible at first edge **104**. First edge **104** has flat appearance **142** without visible core cells **144**.

[0025] In some illustrative examples, composite sandwich panel **100** further comprises second over-crush edge region **146**. Second over-crush edge region **146** comprises second edge **148** with second thickness **150**. Second thickness **150** is less than nominal thickness **138** of composite sandwich panel **100**. Second thickness **150** is in the range of 40%-15% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, second thickness **150** is in the range of 30%-20% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, second thickness **150** has an 80% over-crush. In these illustrative examples, second thickness **150** is approximately 20% of nominal thickness **138** of composite sandwich panel **100**.

[0026] Second edge **148** is cut **152**. Portions of first composite skin **124**, hollow cell core **128**, and second composite skin **126** are visible at second edge **148**. Second edge **148** has flat appearance **142** without visible core cells **144**.

[0027] In some illustrative examples, second face **132** has concave surface **154** within second over-crush edge region **146**. Concave surface **154** may have any desirable shape. In some illustrative examples, concave surface **154** is curved. In some illustrative examples, concave surface **154** is a ramp. In some illustrative examples, concave surface **154** is a combination of straight and curved sections.

[0028] In some illustrative examples, composite sandwich panel **100** further comprises third over-crush edge region **156**. Third over-crush edge region **156** comprises third edge **158** with third thickness **160**. Third thickness **160** is less than nominal thickness **138** of composite sandwich panel **100**. Third thickness **160** is in the range of 40%-15% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, third thickness **160** is in the range of 30%-20% of nominal thickness **138** of composite sandwich panel **100**. In some illustrative examples, third thickness **160** has an 80% over-crush. In these illustrative examples, third thickness **160** is approximately 20% of nominal thickness **138** of composite sandwich panel **100**.

[0029] Third edge **158** is cut **162**. Portions of first composite skin **124**, hollow cell core **128**, and second composite skin **126** are visible at third edge **158**. Third edge **158** has flat appearance **142** without visible core cells **144**.

[0030] In some illustrative examples, second face **132** has concave surface **164** within third over-crush edge region **156**. Concave surface **164** may have any desirable shape. In some illustrative examples, concave surface **164** is curved. In some illustrative examples, concave surface **164** is a ramp. In some illustrative examples, concave surface **164** is a combination of straight and curved sections.

[0031] Composite sandwich panel **100** comprises fourth edge **166**. Fourth edge **166** has fourth thickness **168**. Fourth thickness **168** is substantially the same as nominal thickness **138**. Fourth edge **166** has visible core cells **144**. In some illustrative examples, edge trim **170** is applied to fourth edge **166** to cover visible core cells **144**.

[0032] In some illustrative examples, portions of composite sandwich panel **100** are painted. In some illustrative examples, at least one of first face **130**, first edge **104**, second edge **148**, or third edge **158** is painted. In some illustrative examples, composite sandwich panel **100** further comprises decorative laminate **172**. In some illustrative examples, decorative laminate **172** covers first face **130** and first edge **104**. In some illustrative examples, decorative laminate **172** covers first face **130,** first edge **104**, second edge **148**, and third edge **158**.

[0033] By forming composite sandwich panel **100** in a crush core press, at least one edge is "over-crushed" to the point that the at least one edge behaves like solid fiberglass. In this illustrative example, each of first edge **104**, second edge **148**, and third edge **158** is produced using an "over-crush" process. The "over-crush" process uses heat and pressure to compress hollow cell core **128**, first composite skin **124**, and second composite skin **126** into a solid substrate along each of first edge **104**, second edge **148**, and third edge **158** of composite sandwich panel **100**.

[0034] By using this "over-crush" process on first edge **104**, second edge **148**, and third edge **158,** durable edges are created that do not use edge trims. By using this

"over-crush" process, door **174** takes advantage of the benefits of a composite sandwich panel having a hollow cell core. In particular, a strength and a stiffness of composite sandwich panel **100** is maintained. Increasing a strength and a stiffness of door **174** results in a more durable product.

[0035] Fourth edge **166** of composite sandwich panel **100**, which is not over-crushed, allows volatile compounds to escape during the molding process. An injection-molded edge trim, such as edge trim **170**, can be applied to fourth edge **166**. In some illustrative examples, fourth edge **166** is hidden beneath a countertop where edge trim **170** does not create a decorative concern.

[0036] To form composite sandwich panel **100,** hollow cell core **128**, first composite skin **124**, and second composite skin **126** are placed into tool **176** with dies **178**. When closed, dies **178** of tool **176** form interior shape **180**. Interior shape **180** applies "over-crush" pressure to portions of composite sandwich panel **100** to form first over-crush edge region **106**, second over-crush edge region **146**, and third over-crush edge region **156**.

[0037] After performing an "over-crush" process to form composite sandwich panel **100**, composite sandwich panel **100** is cut using numerically controlled machinery **182**. Numerically controlled machinery **182** is used to form cut **140** first edge **104**, cut **152** second edge **148**, and cut **162** third edge **158**.

[0038] In some illustrative examples, composite sandwich panel **100**, seal **110**, and hinge **112** form door assembly **184**. Door assembly **184** is installed into cabinetry to form a door, such as door **174** of cabinetry **186**.

[0039] Seal **110** is configured to perform desired functions in door assembly **184**. Seal **110** is configured to close a gap of door assembly **184** in cabinetry, such as cabinetry **186**. In some illustrative examples, seal **110** is formed of polymeric material **188**. In some illustrative examples, seal **110** is formed of silicone **190**. In some illustrative examples, polymeric material **188** is reinforced **192.** Seal **110** is bonded to first over-crush edge region **106** after using numerically controlled machinery **182** used to form cut **140** first edge **104**.

[0040] After bonding seal **110** to first over-crush edge region **106**, hinge **112** is connected to composite sandwich panel **100**. In some illustrative examples, hinge **112** is also connected to cabinetry **186** in lavatory **194** of aircraft **196**. In some illustrative examples, hinge **112** is connected to composite sandwich panel **100** prior to connecting hinge **112** to cabinetry **186**. In some illustrative examples, hinge **112** is connected to cabinetry **186** prior to connecting hinge **112** to composite sandwich panel **100**.

[0041] Hinge **112** is connected to composite sandwich panel **100** using fasteners **198**. In some illustrative examples, prior to connecting hinge **112** to composite sandwich panel **100**, drilling and potting steps are performed on composite sandwich panel **100**. In these illustrative examples, the drilling and potting steps position fastener receivers. In these illustrative examples, fasteners **198** are connected to fastener receivers in composite sandwich panel **100**.

[0042] As used herein, the phrase "at least one of," when used with a list of items, means different combinations of one or more of the listed items may be used, and only one of each item in the list may be needed. In other words, "at least one of" means any combination of items and number of items may be used from the list, but not all of the items in the list are required. The item may be a particular object, a thing, or a category.

[0043] This example also may include item A, item B, and item C, or item B and item C. Of course, any combination of these items may be present. In other examples, "at least one of" may be, for example, without limitation, two of item A, one of item B, and ten of item C; four of item B and seven of item C; or other suitable combinations.

[0044] The illustration of manufacturing environment **102** in **Figure 1** is not meant to imply physical or architectural limitations to the manner in which the present disclosure may be implemented. Other components in addition to or in place of the ones illustrated may be used. Some components may be unnecessary. 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 the present disclosure.

[0045] Turning now to **Figure 2**, an illustration of a front view of a lavatory cabinetry with a door formed of a composite sandwich panel is depicted in accordance with the present disclosure. Cabinetry **200** is a physical implementation of cabinetry **186** of **Figure 1**.

[0046] Cabinetry **200** has door **202** and door **204**. Door **202** may be a physical implementation of door **174** of **Figure 1**. Door **204** may be a physical implementation of door **174** of **Figure 1**.

[0047] In some illustrative examples, cabinetry **200** is positioned in lavatory **194** of **Figure 1**. In some illustrative examples, cabinetry **200** may be positioned beneath a countertop.

[0048] Cabinetry **200** is configured to have desirable durability. Further, cabinetry **200** is designed such that door **202** and door **204** are not obviously doors. Cabinetry **200** is designed such that passengers in an aircraft do not probe door **202** and door **204**.

[0049] Turning now to **Figure 3**, an illustration of a back view of a lavatory cabinetry with a door formed of a composite sandwich panel is depicted in accordance with the present disclosure.. View **300** is a back view of cabinetry **200**. As depicted, door **202** is connected to hinge **302**. As depicted, door **204** is connected to hinge **304**.

[0050] Using hinge **302**, door **202** opens in direction **306**. Using hinge **304**, door **204** opens in direction **308**.

[0051] Turning now to **Figure 4**, an illustration of a front isometric view of a composite sandwich panel is depicted in accordance with the present disclosure. Composite sandwich panel **400** is a physical implementation of composite sandwich panel **100** of **Figure 1**. In some illustra-

tive examples, composite sandwich panel **400** is a component of door **202** of **Figure 2**.

[0052] As depicted, composite sandwich panel **400** has first edge **402**, second edge **404**, third edge **406**, and fourth edge **408.** Each of first edge **402**, second edge **404**, and third edge **406** has a flat appearance without visible core cells. First edge **402** is in first over-crush edge region **410**. First over-crush edge region **410** has concave surface **412**.

[0053] Second edge **404** is in second over-crush edge region **414**. Second over-crush edge region **414** has concave surface **416**. Third edge **406** is in third over-crush edge region **418**. Third over-crush edge region **418** has concave surface **420**.

[0054] Turning now to **Figure 5**, an illustration of a back isometric view of a composite sandwich panel is depicted in accordance with the present disclosure. View **500** is a back isometric view of composite sandwich panel **400** from fourth edge **408**.

[0055] As depicted, fourth edge **408** has visible core cells **502.** In some illustrative examples, prior to being placed into service, an edge treatment will be applied to fourth edge **408**. In some illustrative examples, prior to being placed into service, an edge trim is adhered to fourth edge **408**.

[0056] Turning now to **Figure 6**, an illustration of a front isometric view of a composite sandwich panel with a seal is depicted in accordance with the present disclosure. In view **600**, seal **602** has been bonded to first over-crush edge region **410**. Seal **602** extends past first edge **402**. Seal **602** is a physical implementation of seal **110** of **Figure 1**.

[0057] Seal **602** is formed of any desirable material. In some illustrative examples, seal **602** is formed of a polymeric material. In some illustrative examples, seal **602** is formed of a reinforced material.

[0058] Turning now to **Figure 7**, an illustration of a front isometric view of a composite sandwich panel with a seal and a hinge is depicted in accordance with the present disclosure. In view **700**, hinge **702** has been connected to composite sandwich panel **400** such that axis of rotation **704** of hinge **702** is positioned over first over-crush edge region **410** of composite sandwich panel **400**. As depicted, hinge **702** is continuous hinge **706**. As depicted, hinge **702** is gooseneck hinge **708**.

[0059] In some illustrative examples, composite sandwich panel **400**, seal **602**, and hinge **702** are referred to as door assembly **710**. Composite sandwich panel **400** has cut first edge **402**, cut second edge **404**, and cut third edge **406** each with a flat appearance without visible core cells. As depicted, seal **602** is bonded to composite sandwich panel **400** adjacent cut first edge **402**. Hinge **702** is connected to composite sandwich panel **400** adjacent cut first edge **402**.

[0060] As depicted, cut first edge **402** is within first over-crush edge region **410** of composite sandwich panel **400**, wherein seal **602** is bonded to first over-crush edge region **410**. As depicted, hinge **702** is connected to composite sandwich panel **400** such that an axis of rotation of hinge **702** is positioned over first over-crush edge region **410**.

[0061] Turning now to **Figure 8**, an illustration of a side view of a composite sandwich panel is depicted in accordance with the present disclosure. View **800** is a side view of first over-crush edge region **410** of composite sandwich panel **400**.

[0062] As depicted, concave surface **412** of first over-crush edge region **410** is curved **802**. As depicted, first edge **402** is cut **804**. Thickness **806** of first edge **402** is considerably less than nominal thickness **808** of composite sandwich panel **400**.

[0063] Turning now to **Figure 9**, an illustration of a side view of a composite sandwich panel with a seal is depicted in accordance with the present disclosure. View **900** is a side view of first over-crush edge region **410** of composite sandwich panel **400** with seal **602**. As depicted, seal **602** extends over first edge **402**. As depicted, seal **602** stops within first over-crush edge region **410**.

[0064] Turning now to **Figure 10**, an illustration of a side view of a composite sandwich panel with a seal and a hinge is depicted in accordance with the present disclosure. View **1000** is a side view of first over-crush edge region **410** of composite sandwich panel **400** with seal **602** and hinge **702**. Hinge **702** has been connected to composite sandwich panel **400** such that axis of rotation **704** of hinge **702** is positioned over first over-crush edge region **410** of composite sandwich panel **400**. As depicted, hinge **702** is gooseneck hinge **708**. As depicted, seal **602** ends prior to hinge **702**.

[0065] Turning now to **Figure 11**, another illustration of a side view of a composite sandwich panel with a seal and a hinge is depicted in accordance with the present disclosure. View **1100** is a side view of first over-crush edge region **410** of composite sandwich panel **400** with seal **602** and hinge **702**. Hinge **702** has been connected to composite sandwich panel **400** such that axis of rotation **704** of hinge **702** is positioned over first over-crush edge region **410** of composite sandwich panel **400**. As depicted, hinge **702** is gooseneck hinge **708**. As depicted, a portion of seal **602** is sandwiched between hinge **702** and composite sandwich panel **400**.

[0066] Turning now to **Figure 12**, an illustration of a side view of a composite sandwich panel with a seal and a hinge installed in cabinetry and in a closed position is depicted in accordance with the present disclosure.View **1200** is a side view of composite sandwich panel **1202**. Composite sandwich panel **1202** is a physical implementation of composite sandwich panel **100** of **Figure 1**. Composite sandwich panel **1202** may be composite sandwich panel **400** of **Figures 4-11**. In some illustrative examples, composite sandwich panel **1202** is a component of one of door **202** or door **204**.

[0067] As depicted, composite sandwich panel **1202** has first over-crush edge region **1204** with first edge **1206**. Seal **1208** is bonded to first over-crush edge region **1204**. Hinge **1210** is connected to composite sandwich

panel **1202** such that axis of rotation **1212** is positioned over first over-crush edge region **1204**.

[0068] Hinge **1210** is also connected to supporting structure **1214** of cabinetry **1216**. Door assembly **1218** including composite sandwich panel **1202**, seal **1208**, and hinge **1210** is in closed position **1220**. Connecting hinge **1210** to cabinetry **1216** forms a composite door, such as door **202** or door **204** of **Figure 2.** In closed position **1220**, seal **1208** contacts facing **1222**. In closed position **1220**, first face **1224** is substantially flush with facing **1222**. Seal **1208** seals gap **1226** between composite sandwich panel **1202** and facing **1222**. Seal **1208** deters entry of water or other contaminates to interior **1228** of cabinetry **1216**.

[0069] For an acceptable appearance, consistent, tight gaps are desirable between panels. Gaps are desirably closed out while not sacrificing a decorative appearance. When a decorative laminate is applied to composite sandwich panel **1202**, seal **1208** can be colored to match the decorative laminate. Seal **1208** is configured to close out any gaps with a consistent appearance.

[0070] Turning now to **Figure 13**, an illustration of a side view of a composite sandwich panel with a seal and a hinge installed in cabinetry and in an open position is depicted in accordance with the present disclosure. View **1300** is a side view of composite sandwich panel **1202**. In view **1300**, door assembly **1218** is in open position **1302**.

[0071] Turning now to **Figure 14**, an illustration of a flowchart of a method for forming and using a composite sandwich panel is depicted in accordance with the present disclosure. Method **1400** may be used to form door assembly **184** of **Figure 1** or door assembly **1218** of **Figure 12**. Method **1400** may be used to form any of composite sandwich panel **100** of **Figure 1**, composite sandwich panel **400** of **Figure 2,** or composite sandwich panel **1202** of **Figure 12**.

[0072] Method **1400** bonds a seal to a first over-crush edge region of a composite sandwich panel, wherein a thickness of the composite sandwich panel decreases within the first over-crush edge region in a direction towards a first edge of the composite sandwich panel within the first over-crush edge region (operation **1402**). Method **1400** connects a hinge to the first over-crush edge region of the composite sandwich panel (operation **1404**). Afterwards, the method terminates.

[0073] In some illustrative examples, method **1400** also connects the hinge to cabinetry to form a composite door (operation **1406**). In some illustrative examples, the cabinetry is within a lavatory of an aircraft (operation **1408**).

[0074] In some illustrative examples, method **1400** applies heat and a compressive force to the composite sandwich panel to form the first over-crush edge region (operation **1410**). In some illustrative examples, method **1400** applies a decorative laminate over a first face and the first edge of the composite sandwich panel (operation **1412**).

[0075] In some illustrative examples, the first face is opposite to a second face having a concave surface in the first over-crush edge region (operation **1414**). In some illustrative examples, method **1400** applies heat and a compressive force to the composite sandwich panel to form a second over-crush edge region and a third over-crush edge region (operation **1416**).

[0076] In some illustrative examples, method **1400** allows volatiles to escape through a fourth edge of the composite sandwich panel while forming the second over-crush edge region and the third over-crush edge region of the composite sandwich panel (operation **1418**). In some illustrative examples, method **1400** applies a decorative laminate over the first edge, a second edge within the second over-crush edge region, and a third edge within the third over-crush edge region (operation **1420**). In some illustrative examples, method **1400** applies an edge trim to the fourth edge (operation **1422**).

[0077] The flowcharts and block diagrams illustrate the architecture, functionality, and operation of some possible implementations of apparatus and methods in the present disclosure. In this regard, each block in the flowcharts or block diagrams may represent a module, a segment, a function, and/or a portion of an operation or step.

[0078] In some alternative implementations of, the function or functions noted in the blocks may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be performed 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.

[0079] In some illustrative examples, not all blocks of method **1400** are performed. For example, operations **1406** through **1422** are optional.

[0080] The present 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 is depicted in accordance with the present disclosure. During preproduction, aircraft manufacturing and service method **1500** may include specification and design **1502** of aircraft **1600** in **Figure 16** and material procurement **1504**.

[0081] During production, component and subassembly manufacturing **1506** and system integration **1508** of aircraft **1600** takes place. Thereafter, aircraft **1600** may go through certification and delivery **1510** in order to be placed in service **1512**. While in service **1512** by a customer, aircraft **1600** is scheduled for routine maintenance and service **1514**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

[0082] 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 or major-system subcontractors; a third party may include, without limitation, any number of vendors, subcontractors, or suppliers; and an operator may be an airline, a leasing company, a military entity, a service organization, and so on.

[0083] With reference now to **Figure 16**, an illustration of an aircraft is depicted in which the present disclosure 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 a 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, the present disclosure may be applied to other industries, such as the automotive industry.

[0084] Apparatuses and methods embodied herein may be employed during at least one of the stages of aircraft manufacturing and service method **1500**. The present disclosure may be used during component and subassembly manufacturing **1506**, system integration **1508**, or maintenance and service **1514** of **Figure 15**. For example, door assembly **184** including composite sandwich panel **100** may assembled during component and subassembly manufacturing **1506**. As another example, door assembly **184** including composite sandwich panel **100** may be a replacement part during maintenance and service **1514** of **Figure 15**.

[0085] Apparatuses and methods embodied herein may be employed in manufacturing at least one component of aircraft **1600**. For example, composite sandwich panel **100** of **Figure 1** may be manufactured to form a portion of interior **1606.**

[0086] The illustrative examples present methods and apparatuses to use composite sandwich panels, including fiberglass panels, in lieu of standard thermoplastic doors. The illustrative examples present crushed core fiberglass door panels to be used in cabinetry. In some illustrative examples, the cabinetry may be present in the lavatory of an aircraft.

[0087] As presented, the over-crushed door panels can be painted. It is also possible to apply decorative laminates to the decorative surfaces of the over-crushed door panels. The decorative laminate can be wrapped around the three crushed edges for a seamless appearance.

[0088] The use of these over-crushed door panels may increase durability and aesthetics. It is desirable to maintain consistent, tight gaps between panels. It is also desirable to close out gaps while not sacrificing a decorative appearance.

[0089] By bonding a flap seal to the over-crushed edges of the panel, the gaps are closed out. The seal can be colored to match the decorative laminate applied to the panel, and the seal closes out any gaps with a consistent appearance.

[0090] In addition to the flap seal, a new type of continuous (piano) hinge has been created that allows the hinge side of the door to retract into the compartment, which allows the flap seals to avoid interference. The hinge design allows the seal to stay behind the door panel, and closes tightly when the door is closed. The use of a continuous hinge increases durability and reduces sagging. The hinge design maintains straight, tight gaps between door panels.

[0091] Further, the disclosure comprises the following clauses:

Clause 1. An apparatus comprising:

a composite sandwich panel having a first edge in a first over-crush edge region, wherein a thickness of the composite sandwich panel decreases within the first over-crush edge region in a direction towards the first edge;
a seal bonded to the first over-crush edge region of the composite sandwich panel and extending past the first edge; and
a hinge connected to the composite sandwich panel such that an axis of rotation of the hinge is positioned over the first over-crush edge region of the composite sandwich panel.

2. The apparatus of clause 1, wherein the hinge is a continuous hinge.

3. The apparatus of clause 1 or 2, wherein the continuous hinge has a length equivalent to a length of the first edge.

4. The apparatus of any of the clauses 1-3, wherein the hinge is a gooseneck hinge.

5. The apparatus of any of the preceding clauses, wherein the composite sandwich panel has a first face and a second face opposite the first face, and wherein the second face has a concave surface within the first over-crush edge region.

6. The apparatus of clause 5, wherein the composite sandwich panel further comprises a decorative laminate covering the first face and the first edge.

7. The apparatus of any of the preceding clauses, wherein the composite sandwich panel further comprises a second over-crush edge region with a second edge, and a third over-crush edge region with a third edge.

8. The apparatus of any of the preceding clauses, wherein the composite sandwich panel, the seal, and the hinge form a door assembly.

9. The apparatus of any of the preceding clauses, wherein the hinge is connected to cabinetry in a lavatory of an aircraft.

10. The apparatus of any of the preceding clauses, wherein a portion of the seal is sandwiched between the hinge and the composite sandwich panel.

11. The apparatus of any of the preceding clauses, wherein the first edge in the first over-crush edge region has a first thickness in a range of 40%-15% of a nominal thickness of the composite sandwich panel.

12. The apparatus of any of the preceding clauses, wherein the composite sandwich panel comprises a first composite skin, a second composite skin, and a hollow cell core between the first composite skin and the second composite skin.

13. The apparatus of any of the preceding clauses, wherein the first edge has a flat appearance without visible core cells.

14. A method comprising:

bonding a seal to a first over-crush edge region of a composite sandwich panel, wherein a thickness of the composite sandwich panel decreases within the first over-crush edge region in a direction towards a first edge of the composite sandwich panel within the first over-crush edge region; and
connecting a hinge to the first over-crush edge region of the composite sandwich panel.

15. The method of clause 14, further comprising:

connecting the hinge to cabinetry to form a composite door.

16. The method of clause 14 or 15, wherein the cabinetry is within a lavatory of an aircraft.

17. The method of any of the clauses 14-16, further comprising:
applying heat and a compressive force to the composite sandwich panel to form the first over-crush edge region.

18. The method of any of the clauses 14-17, further comprising:
applying a decorative laminate over a first face and the first edge of the composite sandwich panel.

19. The method of clause 18, wherein the first face is opposite to a second face having a concave surface in the first over-crush edge region.

20. The method of any of the clauses 17-19, further comprising:

applying heat and a compressive force to the composite sandwich panel to form a second over-crush edge region and a third over-crush edge region; and
allowing volatiles to escape through a fourth edge of the composite sandwich panel while forming the second over-crush edge region and the third over-crush edge region of the composite sandwich panel.

21. The method of clause 20,further comprising:

applying a decorative laminate over the first edge, a second edge within the second over-crush edge region, and a third edge within the third over-crush edge region; and
applying an edge trim to the fourth edge.

22. An apparatus comprising:

a composite sandwich panel having a cut first edge, a cut second edge, and a cut third edge each with a flat appearance without visible core cells;
a seal bonded to the composite sandwich panel adjacent the cut first edge;and
a hinge connected to the composite sandwich panel adjacent the cut first edge.

23. The apparatus of clause 22, wherein the cut first edge is within a first over-crush edge region of the composite sandwich panel, wherein the seal is bonded to first over-crush edge region, and wherein the hinge is connected to the composite sandwich panel such that an axis of rotation of the hinge is positioned over the first over-crush edge region.

Claims

1. An apparatus comprising:

a composite sandwich panel (100) having a first edge (104) in a first over-crush edge region (106), wherein a thickness (108) of the composite sandwich panel (100) decreases within the first over-crush edge region (106) in a direction towards the first edge (104);
a seal (110) bonded to the first over-crush edge region (106) of the composite sandwich panel (100) and extending past the first edge (104); and
a hinge (112) connected to the composite sandwich panel (100) such that an axis of rotation (114) of the hinge (112) is positioned over the

first over-crush edge region (106) of the composite sandwich panel (100), wherein the hinge (112) is a continuous hinge (116).

2. The apparatus of claim 1, wherein the continuous hinge (116) has a length (118) equivalent to a length (120) of the first edge (104) and wherein the hinge (112) is a gooseneck hinge (122).

3. The apparatus of any preceding claim, wherein the composite sandwich panel (100) has a first face (130) and a second face (132) opposite the first face (130), and wherein the second face (132) has a concave surface (134) within the first over-crush edge region (106).

4. The apparatus of claim 3, wherein the composite sandwich panel (100) further comprises a decorative laminate (172) covering the first face (130) and the first edge (104).

5. The apparatus of any preceding claim, wherein the composite sandwich panel (100) further comprises a second over-crush edge region (146) with a second edge (148), and a third over-crush edge region (156) with a third edge (158).

6. The apparatus of any preceding claim, wherein the composite sandwich panel (100), the seal (110), and the hinge (112) form a door assembly (184).

7. The apparatus of any preceding claim, wherein the hinge (112) is connected to cabinetry (186) in a lavatory (194) of an aircraft (196).

8. The apparatus of any preceding claim, wherein a portion of the seal (110) is sandwiched between the hinge (112) and the composite sandwich panel (100).

9. The apparatus of any preceding claim, wherein the first edge (104) in the first over-crush edge region (106) has a first thickness (136) in a range of 40%-15% of a nominal thickness (138) of the composite sandwich panel (100).

10. The apparatus of any preceding claim, wherein the composite sandwich panel (100) comprises a first composite skin (124), a second composite skin (126), and a hollow cell core (128) between the first composite skin (124) and the second composite skin (126).

11. The apparatus of any preceding claim, wherein the first edge (104) has a flat appearance (142) without visible core cells (144).

12. A method comprising:

bonding a seal (110) to a first over-crush edge region (106) of a composite sandwich panel (100), wherein a thickness of the composite sandwich panel (100) decreases within the first over-crush edge region (106) in a direction towards a first edge (104) of the composite sandwich panel (100) within the first over-crush edge region (106); and

connecting a hinge (112) to the first over-crush edge region (106) of the composite sandwich panel (100).

13. The method of claim 12, further comprising:

connecting the hinge (112) to cabinetry (186) to form a composite door, wherein the cabinetry (186) is within a lavatory (194) of an aircraft (196).

14. The method of any one of claims 12 or 13, further comprising:

applying heat and a compressive force to the composite sandwich panel (100) to form the first over-crush edge region (106).

15. The method of claim 12, further comprising:

applying heat and a compressive force to the composite sandwich panel (100) to form a second over-crush edge region (146) and a third over-crush edge region (156);

allowing volatiles to escape through a fourth edge (166) of the composite sandwich panel (100) while forming the second over-crush edge region (146) and the third over-crush edge region (156) of the composite sandwich panel (100);

applying a decorative laminate (172) over the first edge (104), a second edge (148) within the second over-crush edge region (146), and a third edge (158) within the third over-crush edge region (156); and

applying an edge trim (170) to the fourth edge (166).

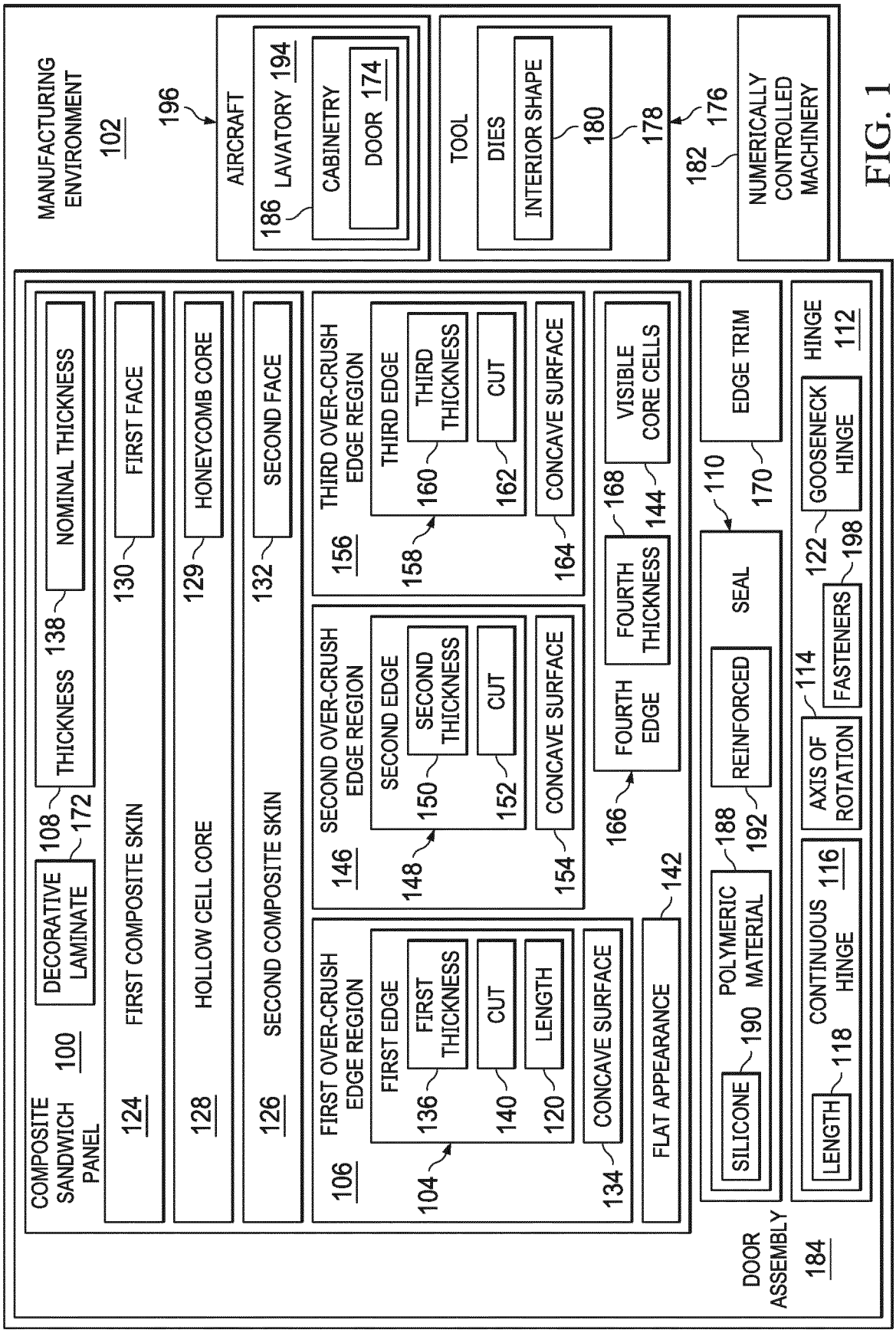
MANUFACTURING ENVIRONMENT
102
196
AIRCRAFT
186
LAVATORY 194
CABINETRY
DOOR 174
TOOL
DIES
INTERIOR SHAPE
180
178
182
176
NUMERICALLY CONTROLLED MACHINERY
COMPOSITE SANDWICH PANEL
100
DECORATIVE LAMINATE
108
172
THICKNESS
138
NOMINAL THICKNESS
124
FIRST COMPOSITE SKIN
130
FIRST FACE
128
HOLLOW CELL CORE
129
HONEYCOMB CORE
126
SECOND COMPOSITE SKIN
132
SECOND FACE
106
FIRST OVER-CRUSH EDGE REGION
FIRST EDGE
104
136
FIRST THICKNESS
140
CUT
120
LENGTH
134
CONCAVE SURFACE
146
SECOND OVER-CRUSH EDGE REGION
SECOND EDGE
148
150
SECOND THICKNESS
152
CUT
154
CONCAVE SURFACE
156
THIRD OVER-CRUSH EDGE REGION
THIRD EDGE
158
160
THIRD THICKNESS
162
CUT
164
CONCAVE SURFACE
FLAT APPEARANCE
142
166
FOURTH EDGE
168
FOURTH THICKNESS
144
VISIBLE CORE CELLS
DOOR ASSEMBLY
184
SILICONE
190
POLYMERIC MATERIAL
188
192
REINFORCED
SEAL
110
EDGE TRIM
170
LENGTH
118
CONTINUOUS HINGE
116
AXIS OF ROTATION
114
FASTENERS
122
198
GOOSENECK HINGE
HINGE
112

FIG. 1

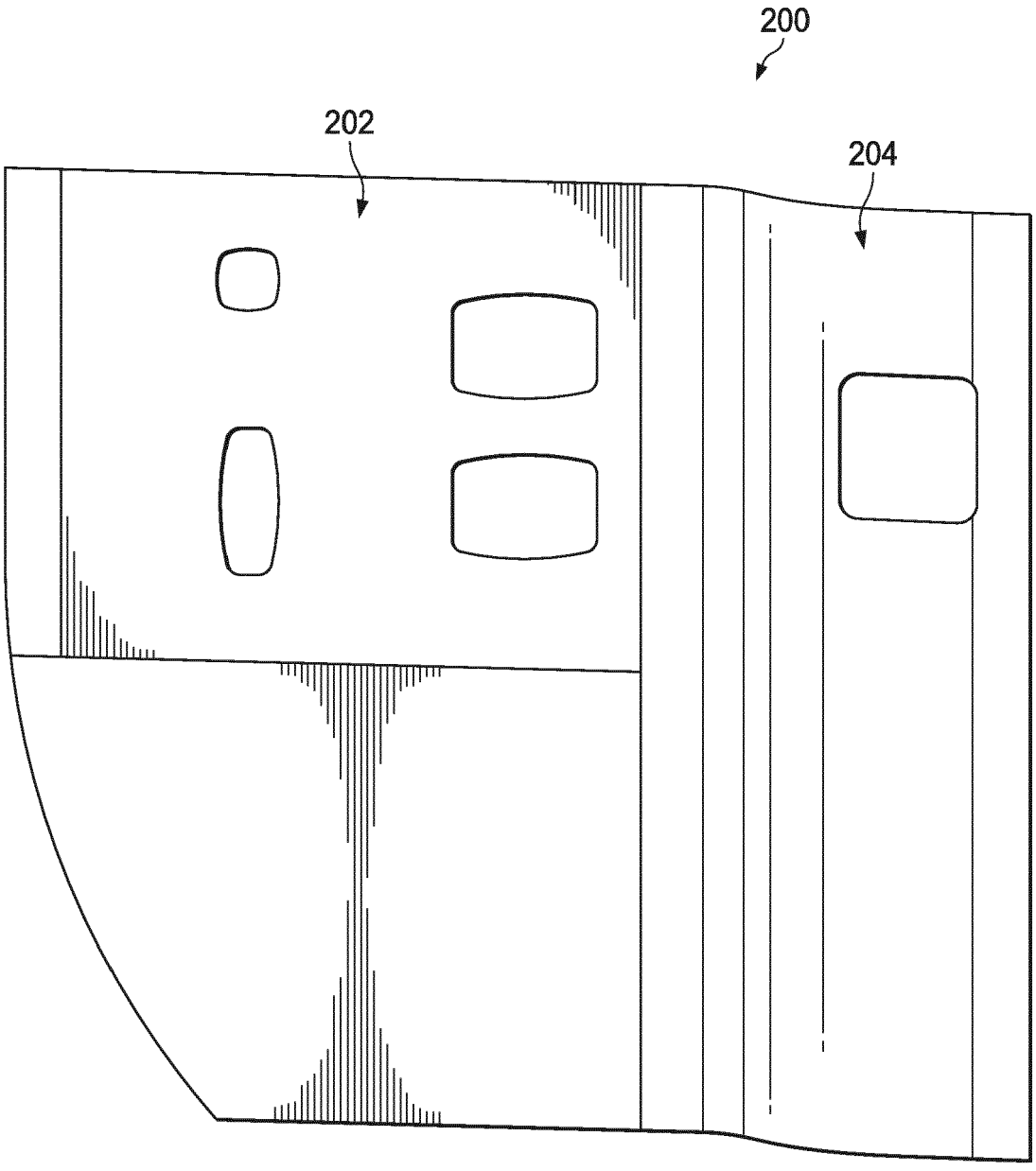

FIG. 2

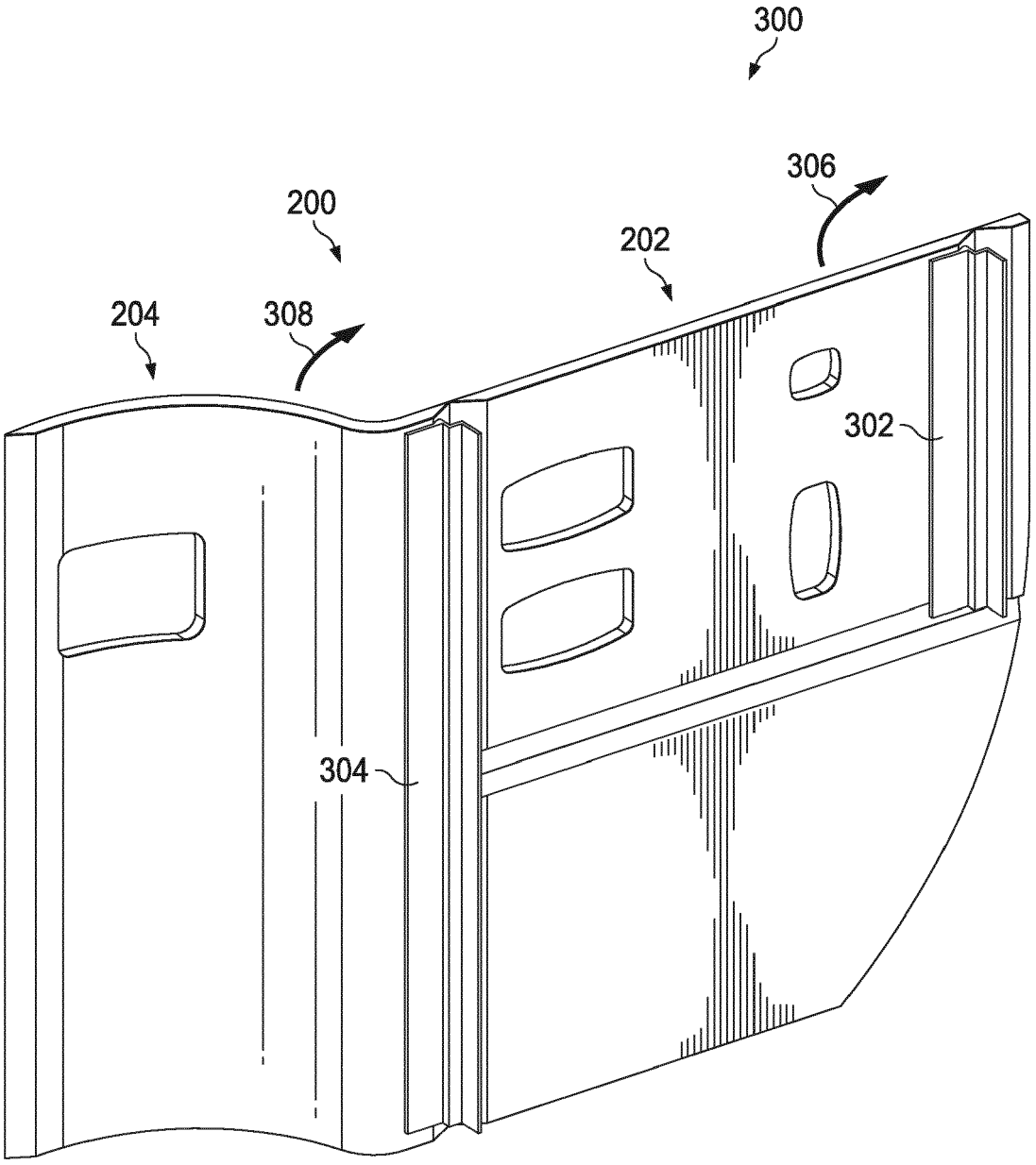

FIG. 3

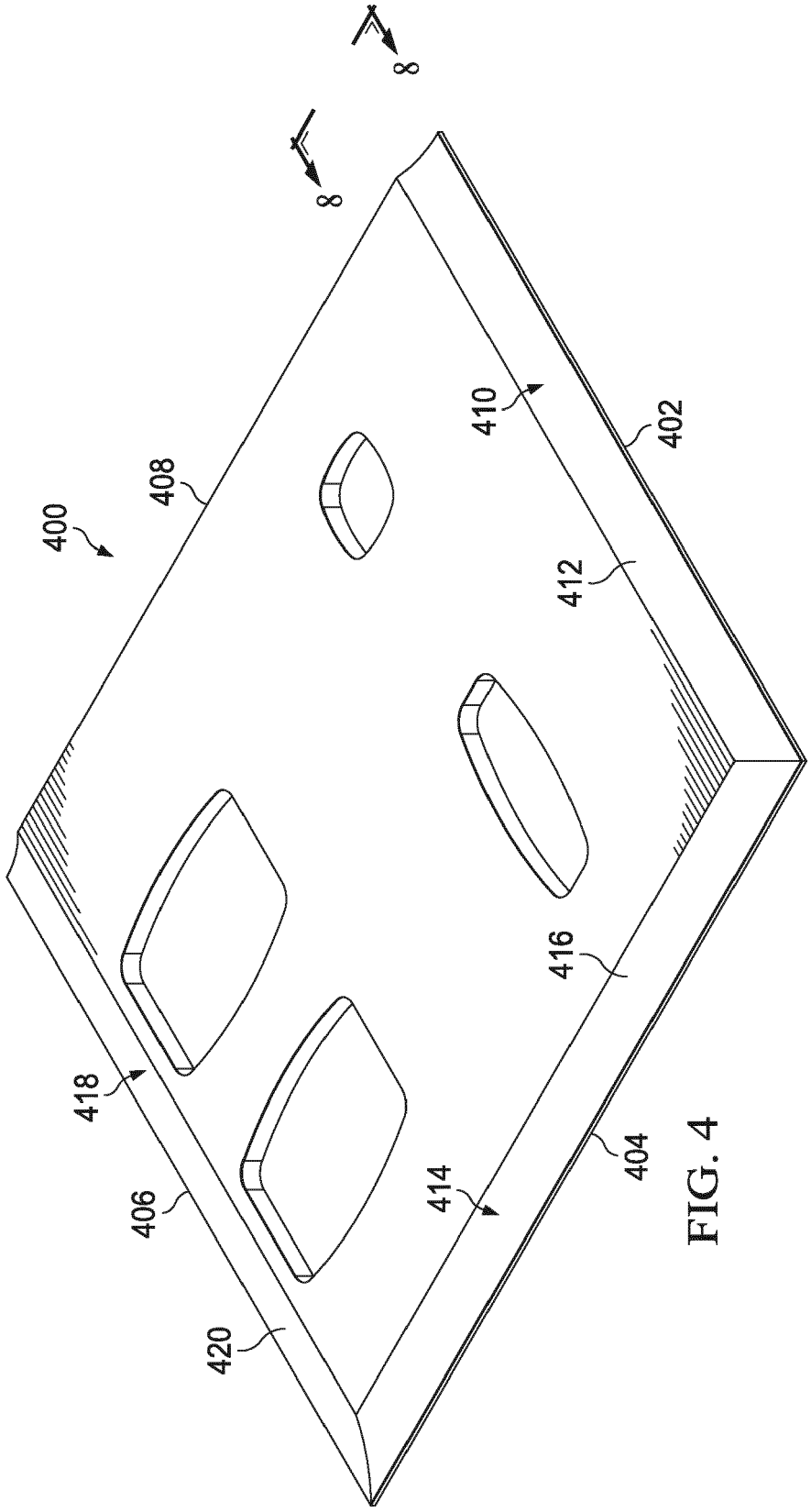

FIG. 4

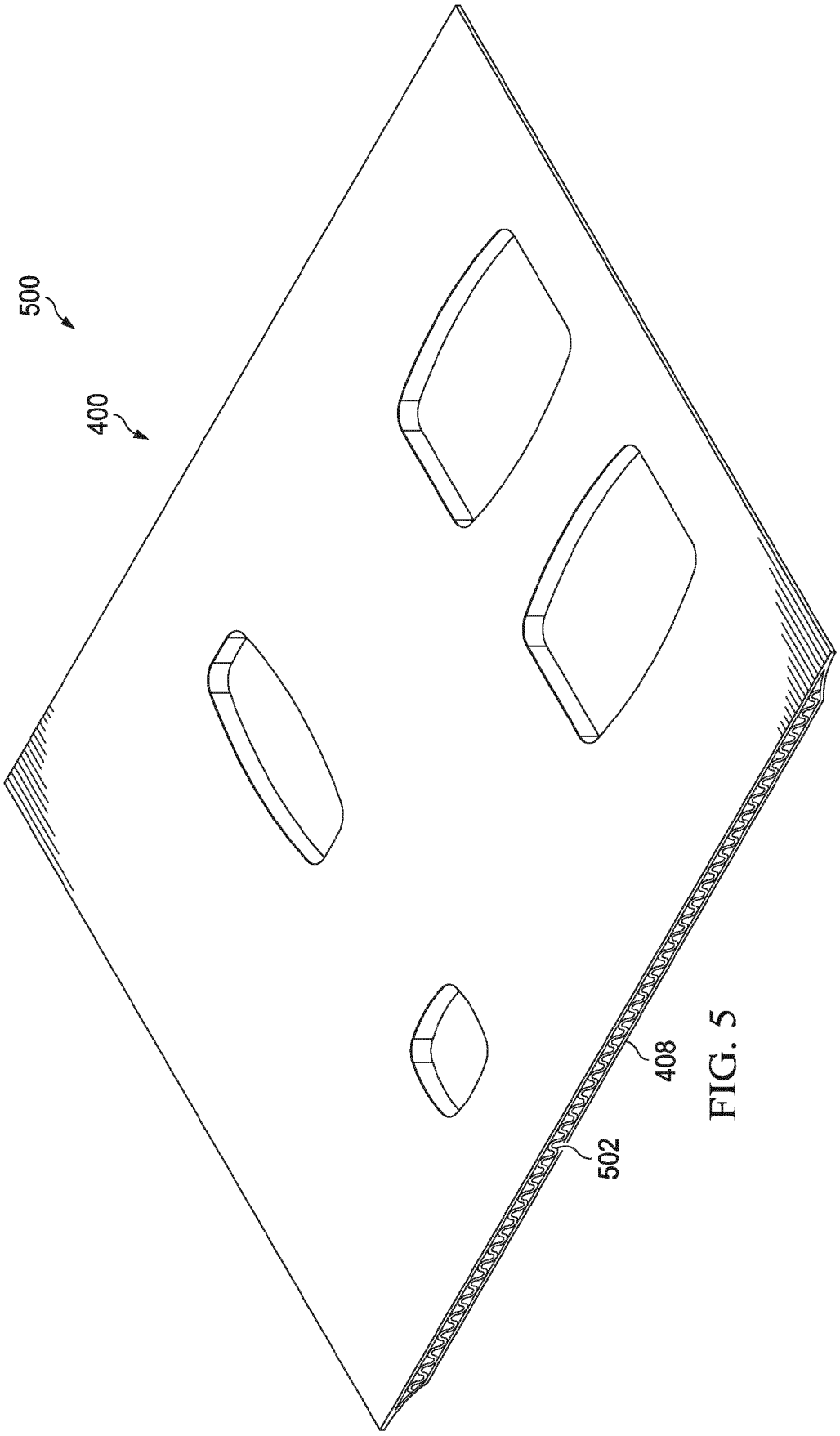

FIG. 5

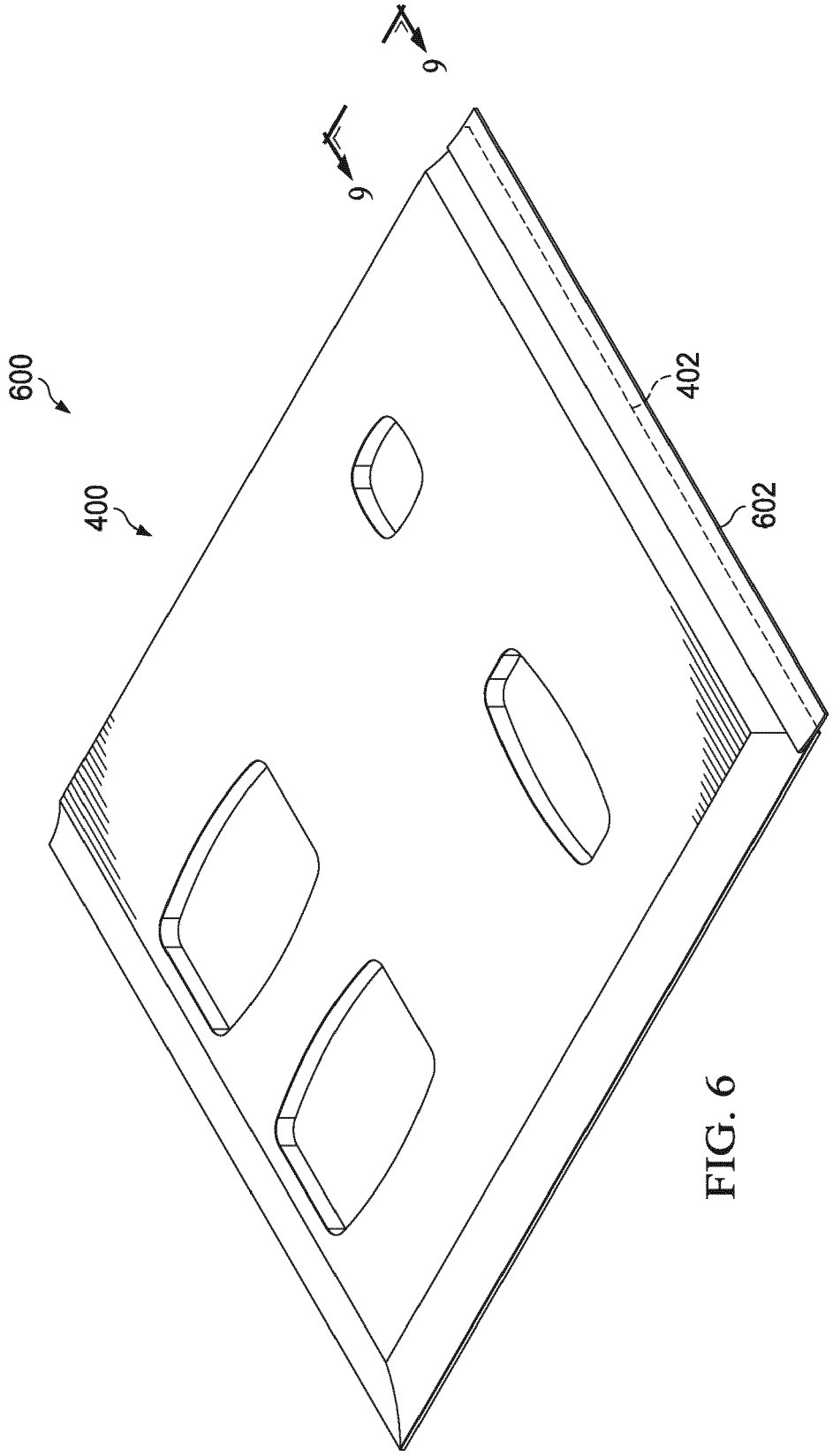

FIG. 6

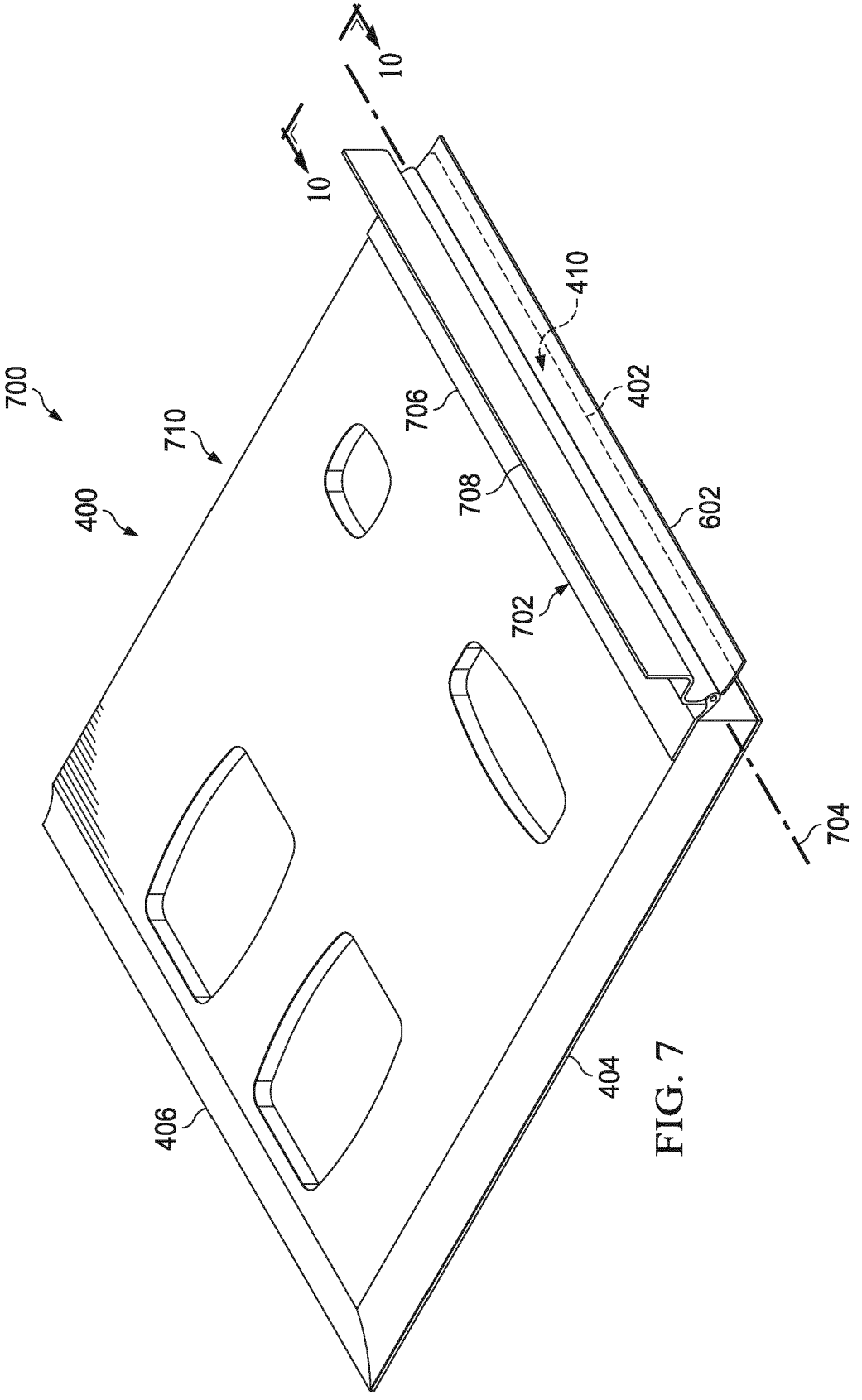

FIG. 7

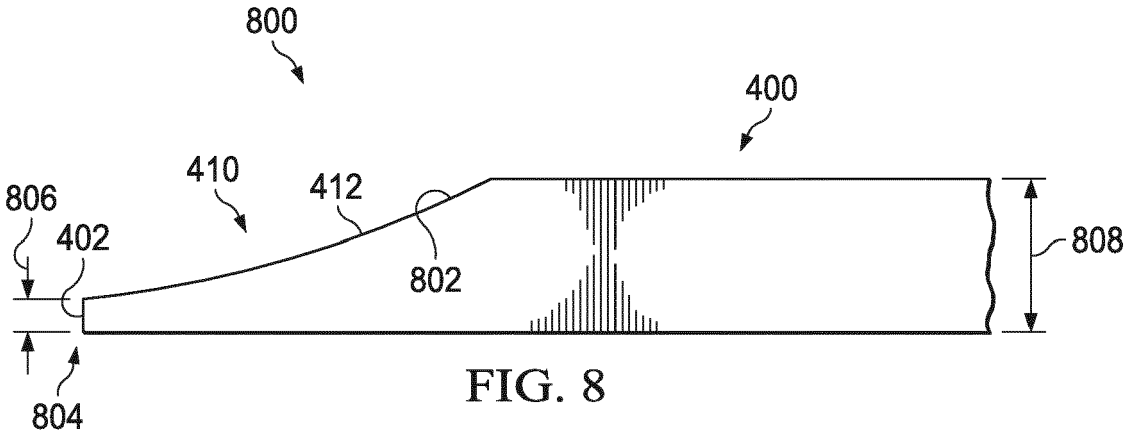

FIG. 8

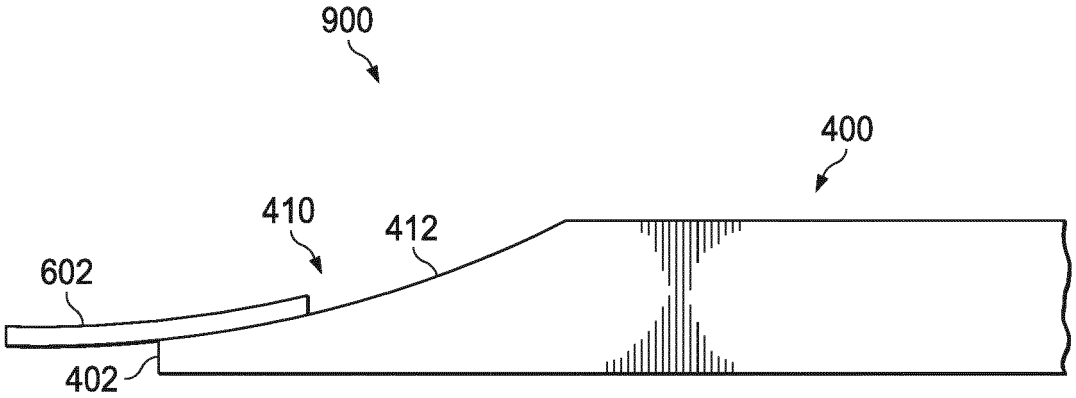

FIG. 9

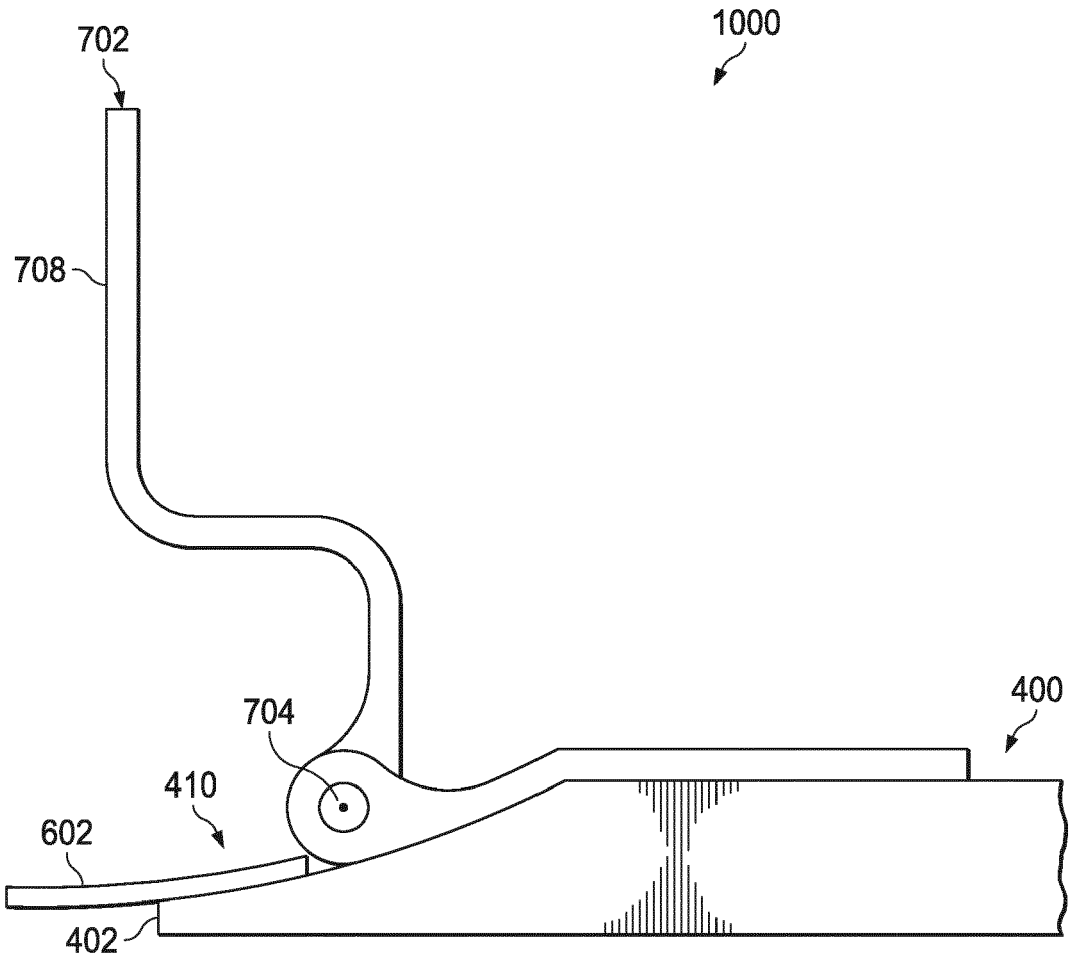

FIG. 10

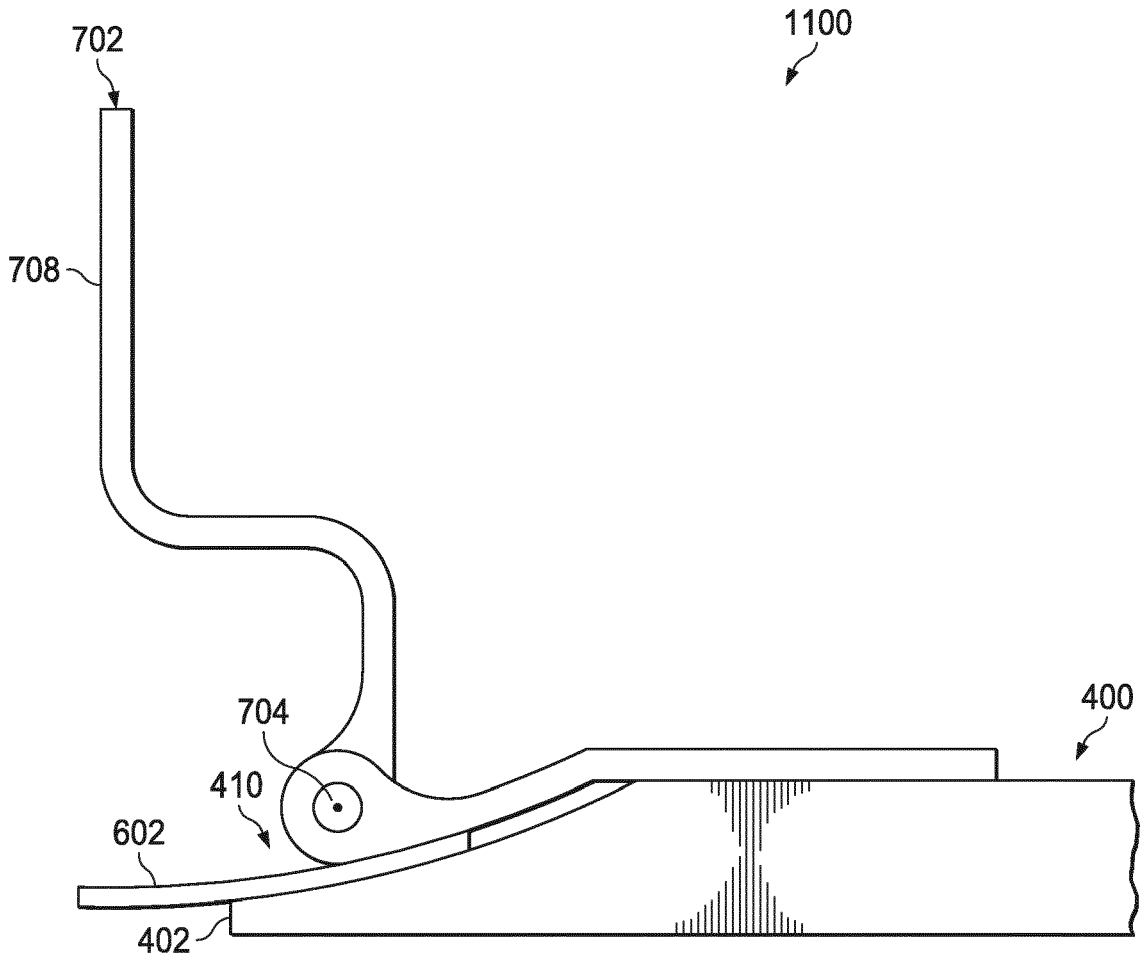

FIG. 11

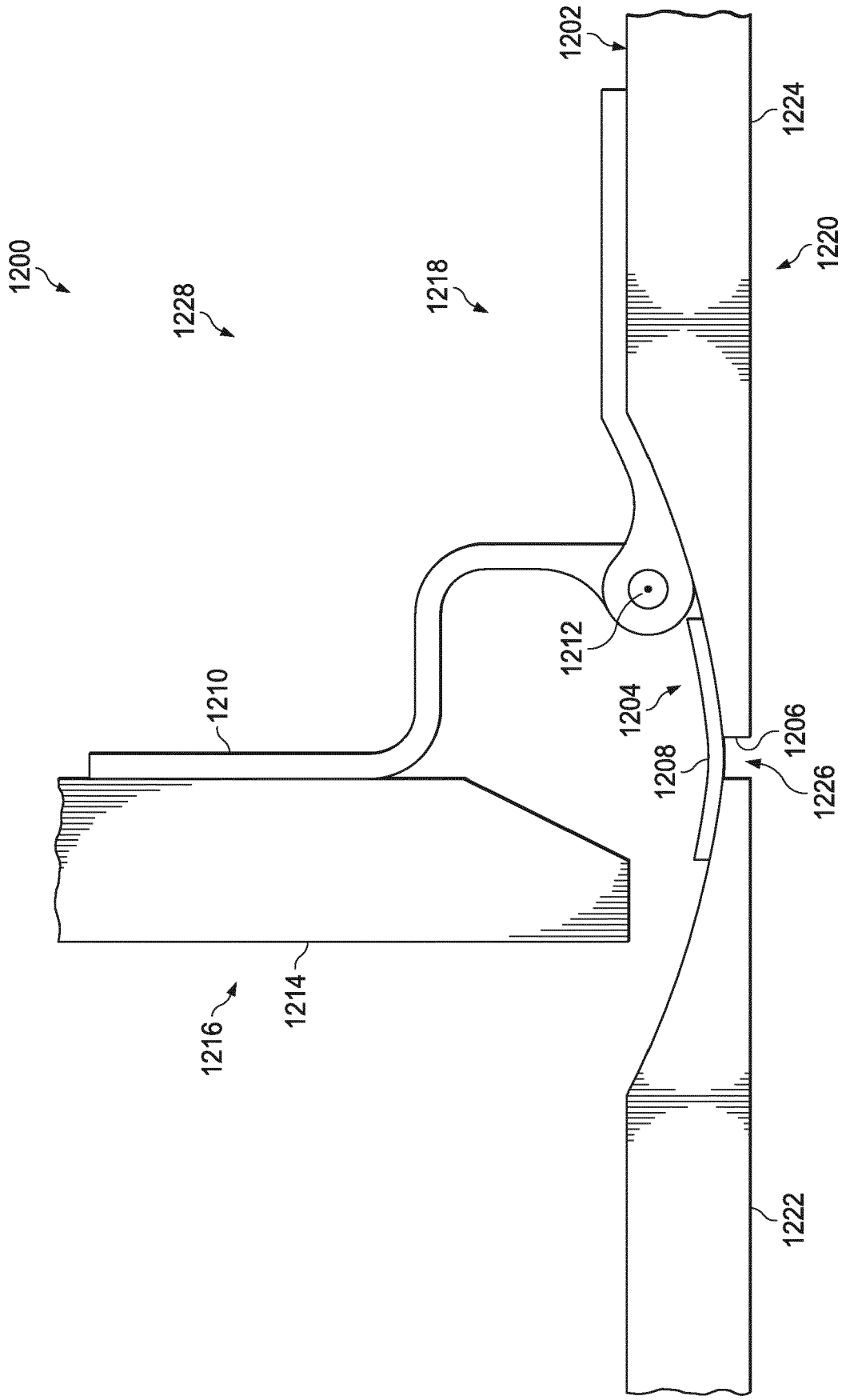
1200
1228
1218
1202
1224
1220
1212
1210
1204
1206
1208
1226
1216
1214
1222

FIG. 12

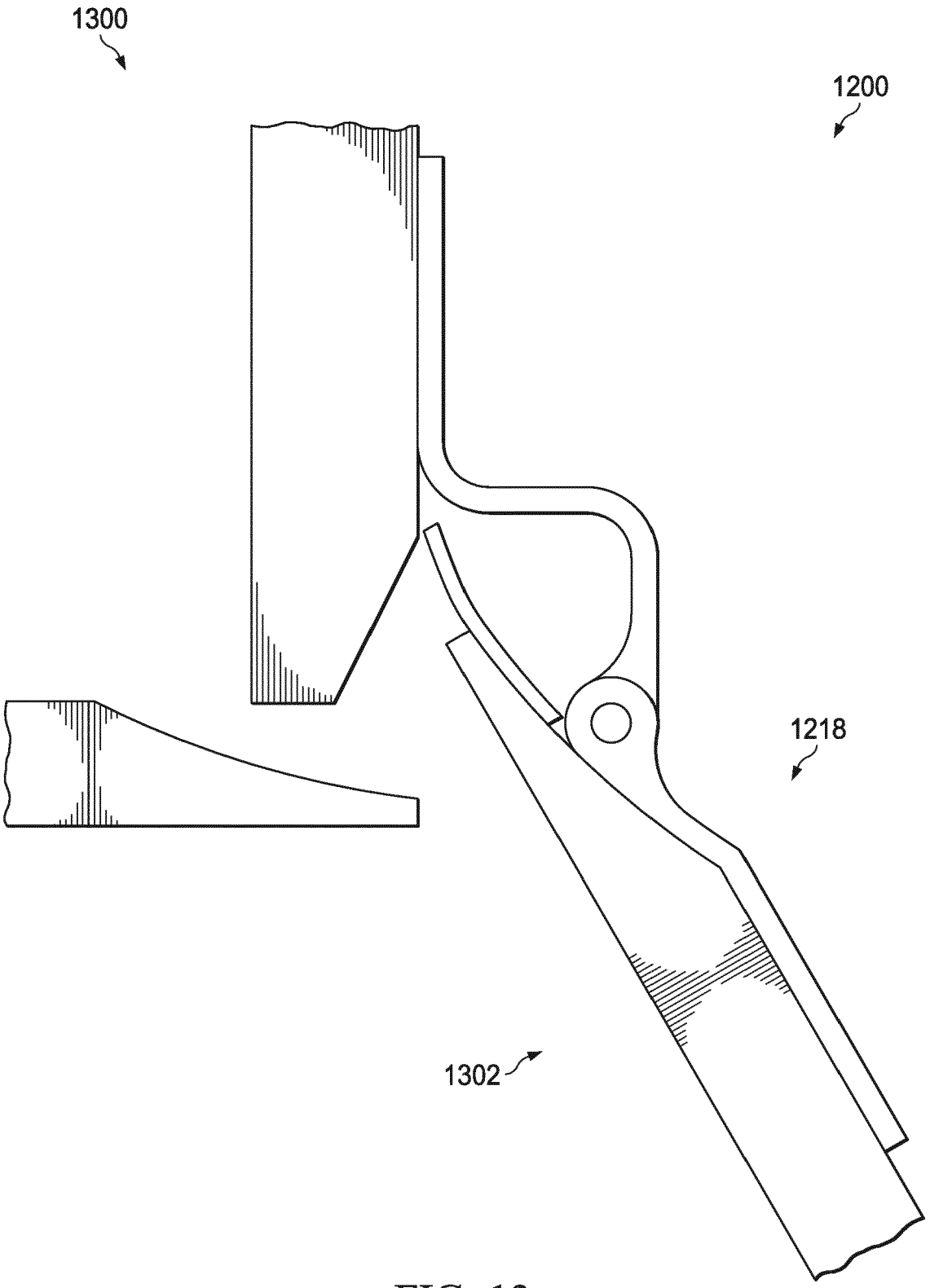

FIG. 13

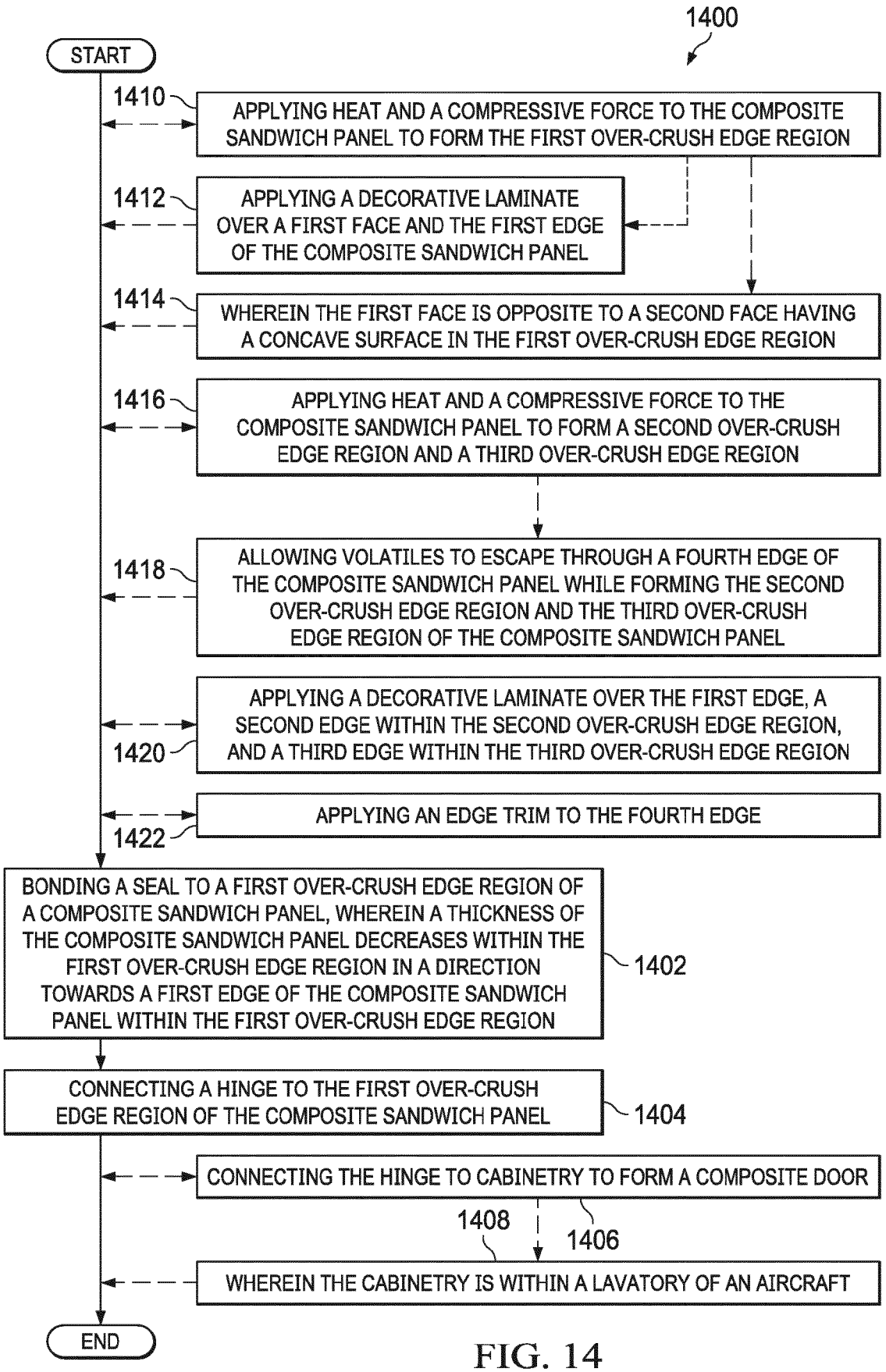
1400
START
1410
APPLYING HEAT AND A COMPRESSIVE FORCE TO THE COMPOSITE SANDWICH PANEL TO FORM THE FIRST OVER-CRUSH EDGE REGION
1412
APPLYING A DECORATIVE LAMINATE OVER A FIRST FACE AND THE FIRST EDGE OF THE COMPOSITE SANDWICH PANEL
1414
WHEREIN THE FIRST FACE IS OPPOSITE TO A SECOND FACE HAVING A CONCAVE SURFACE IN THE FIRST OVER-CRUSH EDGE REGION
1416
APPLYING HEAT AND A COMPRESSIVE FORCE TO THE COMPOSITE SANDWICH PANEL TO FORM A SECOND OVER-CRUSH EDGE REGION AND A THIRD OVER-CRUSH EDGE REGION
1418
ALLOWING VOLATILES TO ESCAPE THROUGH A FOURTH EDGE OF THE COMPOSITE SANDWICH PANEL WHILE FORMING THE SECOND OVER-CRUSH EDGE REGION AND THE THIRD OVER-CRUSH EDGE REGION OF THE COMPOSITE SANDWICH PANEL
APPLYING A DECORATIVE LAMINATE OVER THE FIRST EDGE, A SECOND EDGE WITHIN THE SECOND OVER-CRUSH EDGE REGION, AND A THIRD EDGE WITHIN THE THIRD OVER-CRUSH EDGE REGION
1420
APPLYING AN EDGE TRIM TO THE FOURTH EDGE
1422
BONDING A SEAL TO A FIRST OVER-CRUSH EDGE REGION OF A COMPOSITE SANDWICH PANEL, WHEREIN A THICKNESS OF THE COMPOSITE SANDWICH PANEL DECREASES WITHIN THE FIRST OVER-CRUSH EDGE REGION IN A DIRECTION TOWARDS A FIRST EDGE OF THE COMPOSITE SANDWICH PANEL WITHIN THE FIRST OVER-CRUSH EDGE REGION
1402
CONNECTING A HINGE TO THE FIRST OVER-CRUSH EDGE REGION OF THE COMPOSITE SANDWICH PANEL
1404
CONNECTING THE HINGE TO CABINETRY TO FORM A COMPOSITE DOOR
1408
1406
WHEREIN THE CABINETRY IS WITHIN A LAVATORY OF AN AIRCRAFT
END

FIG. 14

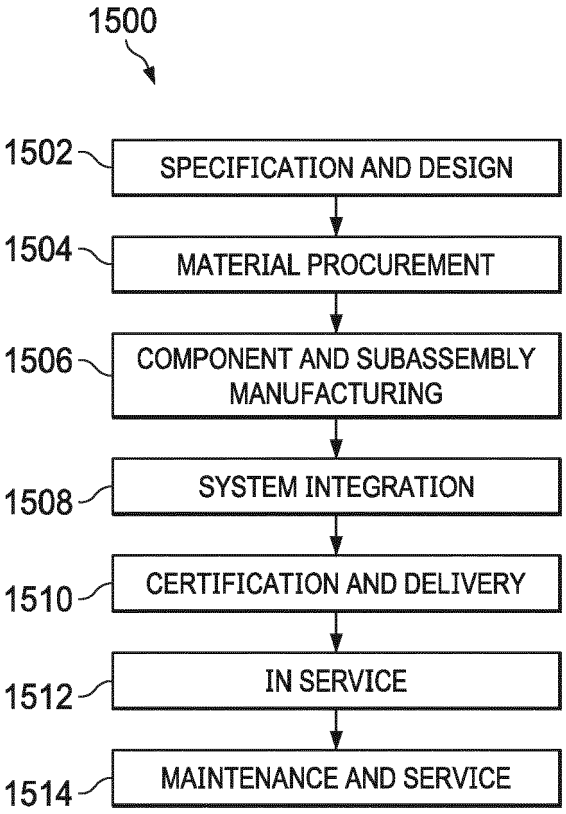
1500
1502
SPECIFICATION AND DESIGN
1504
MATERIAL PROCUREMENT
1506
COMPONENT AND SUBASSEMBLY MANUFACTURING
1508
SYSTEM INTEGRATION
1510
CERTIFICATION AND DELIVERY
1512
IN SERVICE
1514
MAINTENANCE AND SERVICE

FIG. 15

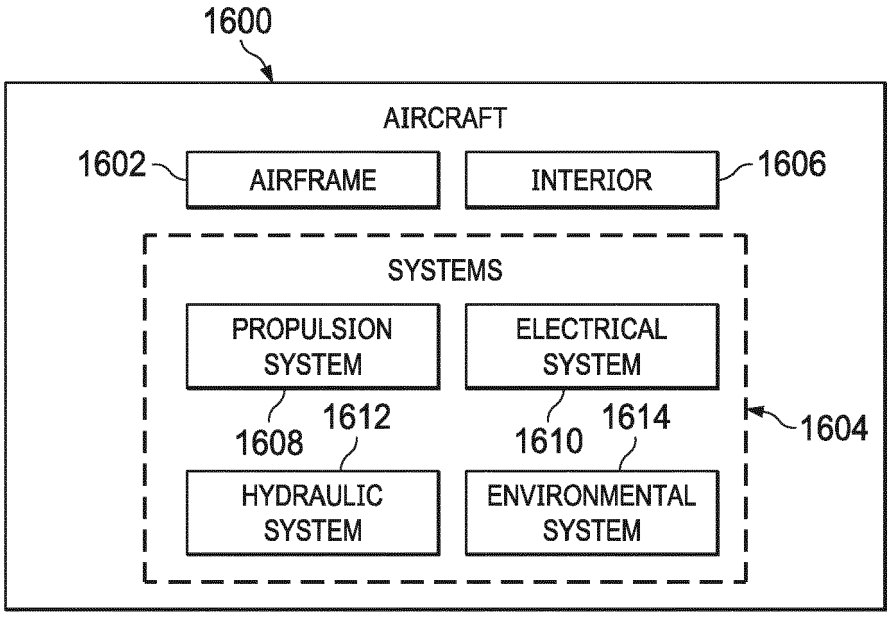
1600
AIRCRAFT
1602
AIRFRAME
INTERIOR
1606
SYSTEMS
PROPULSION SYSTEM
ELECTRICAL SYSTEM
1608
1612
1610
1614
1604
HYDRAULIC SYSTEM
ENVIRONMENTAL SYSTEM

FIG. 16

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 24 8071

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	US 2009/095841 A1 (EVEKER JAMES V [US] ET AL) 16 April 2009 (2009-04-16) * paragraph [0002] - paragraph [0028] * * claims 1-8 * * figures 1-5 *	1,2,5-8, 11-14 4 15	INV. B64C1/14
X Y A	EP 0 939 190 A2 (TEKLA TECHNIK TOR & TUER GMBH [DE]) 1 September 1999 (1999-09-01) * paragraph [0013] - paragraph [0020] * * figures 1-6 *	1,3,6, 8-12,14 4 15	
X	DE 297 08 001 U1 (MUELLER GUENTER [DE]) 10 July 1997 (1997-07-10) * pages 1-5 * * figure 1 *	1,3,4,6, 9-12,14	
A	US 2016/194068 A1 (SAVIAN SCOTT [US] ET AL) 7 July 2016 (2016-07-07) * paragraph [0039] - paragraph [0062] * * figures 1-18 *	1-15	
A	US 2014/291446 A1 (REAMS EDWARD [US] ET AL) 2 October 2014 (2014-10-02) * paragraph [0075] - paragraph [0082] * * figures 22-28 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) B64C B64D B32B E04C
A	DE 10 2011 000258 A1 (ASECOS GMBH SICHERHEIT UND UMWELTSCHUTZ [DE]) 31 May 2012 (2012-05-31) * paragraph [0022] - paragraph [0026] * * figures 1, 2 *	1,12	E06B
A	US 2 559 087 A (PHILIPP LAWRENCE A) 3 July 1951 (1951-07-03) * column 1, line 32 - column 3, line 9 * * figures 1-3 *	1,12	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 June 2019	Glück, Michael

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 24 8071

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-06-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009095841 A1	16-04-2009	US 2004113016 A1	17-06-2004
		US 2006006286 A1	12-01-2006
		US 2009095841 A1	16-04-2009
EP 0939190 A2	01-09-1999	AT 229609 T	15-12-2002
		DE 19808485 C1	17-06-1999
		DK 0939190 T3	07-04-2003
		EP 0939190 A2	01-09-1999
		ES 2189297 T3	01-07-2003
		PT 939190 E	30-04-2003
DE 29708001 U1	10-07-1997	NONE	
US 2016194068 A1	07-07-2016	US 2016194068 A1	07-07-2016
		US 2016355264 A1	08-12-2016
US 2014291446 A1	02-10-2014	NONE	
DE 102011000258 A1	31-05-2012	NONE	
US 2559087 A	03-07-1951	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82