(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 October 2014 (09.10.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/164121 A1

(51) International Patent Classification:
B64C 1/12 (2006.01)

(21) International Application Number:
PCT/US2014/020663

(22) International Filing Date:
5 March 2014 (05.03.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/800,464 13 March 2013 (13.03.2013) US

(71) Applicant: **GULFSTREAM AEROSPACE CORPORATION** [US/US]; P.O. Box 2206 M/S B-06, Savannah, Georgia 31402 (US).

(72) Inventor; and
(71) Applicant : **SAMMONS, Guy** [US/US]; P.O. Box 2206 M/S B-06, Savannah, Georgia 31402 (US).

(74) Agent: **RODACK, Seth**; Ingrassia, Fisher & Lorenz, 7010 E. Cochise Rd., Scottsdale, Arizona 85253 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: AIRCRAFT COMPONENT AND METHOD OF MAKING AN AIRCRAFT COMPONENT

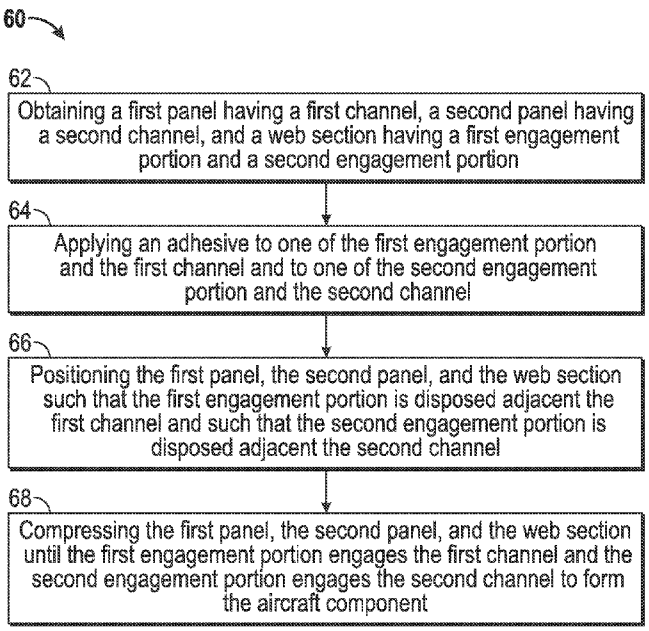


FIG. 7

(57) Abstract: An aircraft component includes, but is not limited to, a first panel including a first channel and a second panel including a second channel. The second panel is disposed such that the second channel is aligned with the first channel. The aircraft component further includes, but is not limited to, a web section that disposed adjacent the first and second panels. The web section includes a first engagement portion engaged with the first channel and a second engagement portion engaged with the second channel. The aircraft component further includes, but is not limited to an adhesive that is disposed between the first engagement portion and the first channel and between the second engagement portion and the second channel. The first panel and the second panel are joined together by cooperation of the web section and the adhesive.

WO 2014/164121 A1

AIRCRAFT COMPONENT AND METHOD OF MAKING AN AIRCRAFT COMPONENT

TECHNICAL FIELD

[0001] The present invention generally relates to aircraft and more particularly relates to an aircraft component and a method for making an aircraft component.

BACKGROUND

[0002] Modern passenger aircraft include many different components. Several of these components come into contact with the free stream while the aircraft is in flight. Some common aircraft components include the wings, the flaps, the ailerons, the vertical stabilizer and the horizontal stabilizer, to name just a few. Such components commonly include upper and lower panels that interface with the free stream and an internal support structure that supports the upper and lower panels and that gives the aircraft component its shape.

[0003] An important design goal for aircraft designers is to minimize the weight of an aircraft as much as possible. Towards this end, the upper and lower panels of an aircraft component have historically been fabricated from lightweight metals, such as aluminum. In recent years, however, there has been movement away from the use of lightweight metals in the construction of the upper and lower panels in favor of composite materials. This is because composite materials weigh significantly less than metal materials.

[0004] Another important design goal for aircraft designers is to minimize the cost of manufacturing the aircraft. Towards this end, low cost materials are preferred over higher cost materials.

[0005] The goal of using lightweight materials in the manufacture of aircraft and the goal of reducing the cost of manufacturing an aircraft are sometimes at odds with one another. For example, lightweight metals such as aluminum are heavier than, but are also less expensive than, composites materials. This situation requires aircraft designers to choose between constructing a light weight aircraft component and constructing a low cost aircraft component.

[0006] Another problem associated with the manufacture of aircraft components is the increasing level of complexity associated with their assembly. The assembling of a typical aircraft component may entail the precise alignment of upper and lower panels, the precise positioning of internal support structures, the precise alignment of rivets or other fasteners, the use of braces and other temporary support structures to hold the various components in their respective positions during the assembly process and the removal of such temporary support structures subsequent to assembly of the aircraft component. Such elaborate assembly requirements can pose a very complicated mechanical challenge to a work force that is increasingly computer savvy and diminishingly mechanically inclined.

[0007] Accordingly, it is desirable to provide an aircraft component that addresses the design objectives of both lower cost and lower weight. Furthermore, it is desirable to provide an aircraft component that can reduce the complexity associated with its assembly. Other desirable features and characteristics will become apparent from the subsequent summary and detailed description and the appended claims, taken in conjunction with the accompanying drawings and the foregoing technical field and background.

BRIEF SUMMARY

[0008] An aircraft component and a method of making an aircraft component are disclosed herein.

[0009] In a first non-limiting embodiment, the aircraft component includes, but is not limited to, a first panel including a first channel. The aircraft component further includes, but is not limited to, a second panel including a second channel. The second panel is disposed such that the second channel is aligned with the first channel. The aircraft component further includes, but is not limited to, a web section that is disposed adjacent the first panel and the second panel. The web section includes a first engagement portion and a second engagement portion. The first engagement portion is engaged with the first channel and the second engagement portion is engaged with the second channel. The aircraft component further including, but not limited to, an adhesive that is disposed between the first engagement portion and the first channel and between the second engagement portion and the second channel. The first panel and the second panel are joined together by cooperation of the web section and the adhesive.

[0010] In another non-limiting embodiment, the method includes, but is not limited to, obtaining a first panel having a first channel, a second panel having a second channel, and a web section having a first engagement portion and a second engagement portion. The method further includes, but is not limited to, applying an adhesive to one of the first engagement portion and the first channel and to one of the second engagement portion and the second channel. The method further includes, but is not limited to, positioning the first panel, the second panel, and the web section such that the first engagement portion is disposed adjacent the first channel and such that the second engagement portion is disposed adjacent the second channel. The method further includes, but is not limited to, compressing the first panel, the second panel, and the web section until the first engagement portion engages the first channel and the second engagement portion engages the second channel to form the aircraft component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention will hereinafter be described in conjunction with the following drawing figures, wherein like numerals denote like elements, and

[0012] FIG. 1 is a perspective view of a non-limiting embodiment of an aircraft component made in accordance with the teachings of the present disclosure;

[0013] FIG. 2 is a perspective view of the aircraft component of FIG. 1 with an upper panel removed;

[0014] FIG. 3 is a perspective view of a non-limiting embodiment of an upper panel compatible for use with the aircraft component illustrated in FIG. 1;

[0015] FIG. 4 is a perspective view of a non-limiting embodiment of a web section compatible for use with the aircraft component illustrated in FIG. 1;

[0016] FIG. 5 is an exploded cross-sectional view illustrating a portion of the aircraft component of FIG. 1 prior to assembly;

[0017] FIG. 6. is an expanded cross-sectional view of the portion of FIG. 5 subsequent to assembly; and

[0018] FIG. 7 is a flow diagram illustrating an embodiment of a method for making an aircraft component in accordance with the teachings of the present disclosure.

DETAILED DESCRIPTION

[0019] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following detailed description.

[0020] An improved aircraft component is disclosed herein. In an embodiment, the aircraft component includes an upper panel having a least one upper panel channel, a lower panel having at least one lower panel channel, and at least one web section having an upper channel engagement portion and a lower channel engagement portion. The web section and the upper and lower panels are configured to engage one another. In some embodiments, these components are configured to engage one another in a snap-fit manner. In other embodiments, these components may engage one another in a tongue-in-groove manner. In other embodiments, other configurations that permit engagement between the components may also be employed. Such engagement permits rapid, simple, and repeatable assembly of the aircraft component. Adhesive is applied where the upper and lower engagement portions engage the upper channel and the lower channel, respectively.

[0021] The individual components can be loosely assembled in a press, and through the application of compressive forces, can be quickly coupled to one another. The completed aircraft component can then be immediately removed from the press without waiting for the adhesive to cure. Such immediate removal is made possible because the engagement of the components permits them to maintain their coupled configuration despite the absence of the compressive forces from the press and despite the adhesive forces of the cured adhesive. This ability to remove the assembled aircraft component from the press before the adhesive cures facilitates the rapid fabrication of multiple aircraft components in the time previously required to fabricate one aircraft component.

[0022] A conventional aircraft component couples the upper and lower panels to the web sections through the use of fasteners (e.g., rivets, bolts, and the like). Such fasteners

add weight and, in some applications, an aesthetically displeasing appearance to the finished aircraft component. The aircraft component disclosed herein, however, uses the adhesive to couple the upper and lower panels to the web sections and therefore eliminates the fasteners from the finished assembly. By eliminating the fasteners, in some instances the aircraft component can be made of lightweight metals such as aluminum, yet have a weight that is roughly equivalent or lower than a comparably sized composite aircraft component. Thus, the various configurations disclosed herein provide the cost advantage associated with lightweight metals and the weight advantage associated with composite materials. Additionally, the use of channels and web sections that engage one another in a snap-fit manner simplifies the assembly process, thereby permitting existing workforces to easily and quickly assembly the aircraft components.

[0023] A greater understanding of the aircraft component described above and of the method for making the aircraft component may be obtained through a review of the illustrations accompanying this application together with a review of the detailed description that follows.

[0024] FIG. 1 is a perspective view illustrating a non-limiting embodiment of an aircraft component 10 made in accordance with the teachings of the present disclosure. Aircraft component 10 may be suitable for use in a wing, an aileron, a flap, a vertical stabilizer, a horizontal stabilizer, and/or any other part of an aircraft that comes in contact with the free stream. In some embodiments, aircraft component 10 may be suitable for use in other applications that do not come into contact with the free stream but rather, are internal to the aircraft. Although aircraft component 10 is disclosed and discussed as comprising a component of an aircraft, it should be understood that it may also be used in other types vehicles including watercraft, automobiles, and space craft. Additionally, the teachings herein are not limited to use solely with vehicles, but may also be employed in a wide variety of non-vehicular applications as well.

[0025] Aircraft component 10 includes an upper panel 12, a lower panel 14, and a plurality of web sections such as web section 16, web section 18, and web section 20. Upper panel 12 and lower panel 14 include channels (see FIG. 3) to receive the various web sections and to ensure their proper alignment and positioning during the assembly process.

[0026] In the illustrated embodiment, upper panel 12 and lower panel 14 are coupled together by the cooperation of web sections 16, 18, and 20 with an adhesive. Unlike conventional aircraft components, aircraft component 10 does not require the use of rivets, nuts, bolts, or other fasteners to maintain upper panel 12 and lower panel 14 in a coupled relationship. Laboratory testing has been performed and has confirmed that the use of a web section (such as web sections 16, 18, and 20) with an adhesive to join upper and lower panels (such as upper panel 12 and lower panel 14) provides a robust coupling despite the absence of any additional mechanical fasteners. In some examples, testing has revealed that the solid metal portions of web sections 16, 18, and 20 will fail under stress before failure occurs in the joint formed between the web sections and the channels of the upper and lower panels. The use of snap-fit joints and an adhesive to join web sections 16, 18, and 20 to upper and lower panels 12 and 14 yields a substantial weight savings over conventional aircraft components that utilize mechanical fasteners.

[0027] FIG. 2 is a perspective view illustrating aircraft component 10 with upper panel 12 (see FIG. 1) removed to permit observation of the interior of aircraft component 10. Web sections 18 and 20 are arranged at a transverse angle to the three illustrated web sections 16. This transverse arrangement enhances the structural stability of aircraft component 10. The spacing between web sections 16 and/or between web sections 18 and 20 can be varied depending upon desired weight/strength/stiffness goals for aircraft component 10.

[0028] In the illustrated embodiment, web sections 16, 18, and 20 (and the corresponding channels in upper panel 12 and lower panel 14) extend for substantially the entire length along upper panel 12 and lower panel 14. In other embodiments, the web sections and corresponding channels may extend only partially along a length of the upper and lower panels without departing from the teachings of the present disclosure.

[0029] FIG. 3 is a perspective view of upper panel 12. Lower panel 14 (see FIG. 1) is substantially identical and therefore the description provided herein with respect to upper panel 12 applies equally to lower panel 14. A plurality of channels are disposed on a surface 22 of upper panel 12. In the illustrated embodiment, channels 24 and 26 extend in a longitudinal direction along surface 22 while channels 28, 30, and 32 extend laterally along surface 22. While in the illustrated embodiment, channels 24, 26, 28, 30, and 32 are disposed on surface 22 and protrude above surface 22, in other embodiments, the channels

may be defined in upper panel 12 such that they are disposed below surface 22. As will be discussed in greater detail below, channels 24, 26, 28, 30, and 32 include a pair of oppositely disposed lips that are configured to engage a barb disposed along an engagement portion of web sections 18, 20, and 16, respectively. This configuration permits upper panel 12 and lower panel 14 to snap-fit to web sections 16, 18, and 20. Other configurations to permit engagement are also possible.

[0030] FIG. 4 is a perspective view illustrating web section 16. With continued reference to FIGS. 1-3, web section 16 has a tapered contour to impart a desired taper to aircraft component 10. Web section 16 further includes openings 34 that extend through web section 16. Openings 34 reduce the amount of material that is needed to fabricate web section 16, thus reducing both the weight and the cost of web section 16.

[0031] Web section 16 further includes engagement portions 36 disposed along opposite sides of web section 16. In some embodiments, engagement portions 36 may have a thickness that differs from the thickness of the remainder of web section 16. Engagement portions 36 are configured to engage channels 28, 30, and 32 of upper panel 12 and lower panel 14 in a snap-fit manner. In the illustrated embodiment, engagement portions 36 each include a barb 37 that extends along a length of each engagement portion 36 to facilitate snap-fit engagement with channels 28, 30, and 32. In the illustrated embodiment, barb 37 extends along an entire length of each engagement portion 36 while in other embodiments, barb 37 may extend for only a portion of the length along each engagement portion 36, while in still other embodiments, barb 37 may extend in a broken or intermittent manner along each engagement portion 36.

[0032] Web section 16 further includes engagement portions 38. Engagement portions 38 are configured to engage channels that are disposed on web sections 18 and 20. Engagement (e.g., snap-fit engagement) of engagement portions 38 with channels disposed on web sections 18 and 20 enhances the strength and stability of aircraft component 10, imparting a matrix-like structure to the finished component.

[0033] FIG. 5 is an exploded cross-sectional view illustrating a portion of aircraft component 10. Upper panel 12 and lower panel 14 are positioned opposite one another such that their respective channels 30 come into alignment. Web section 16 is positioned between upper panel 12 and lower panel 14 such that the upper and lower engagement

portions 36 are aligned with channels 30 or upper panel 12 and lower panel 14, respectively. Although web section 16 has been illustrated at a substantially perpendicular angle with respect to upper panel 12 and lower panel 14, it should be understood that channels 30 may be oriented at any desirable angle which would, in turn, permit web section 16 to engage upper panel 12 and lower panel 14 at a corresponding angle.

[0034] In the view presented in FIG. 5, barbs 37 of each engagement portion 36 can be observed. Additionally, each channel 30 includes a pair of lips 40 that are configured to form a cavity 42. Cavity 42 is configured to engage with, and retain, barb 37 once barb 37 engages channel 30.

[0035] Before engagement portions 38 are engaged with channels 30, an adhesive is applied to the joint. The adhesive may be either a liquid adhesive 44 or a film adhesive 46, or both. If liquid adhesive 44 is utilized, it is squeezed into channel 30 before engagement portion 38 is inserted into channel 30. If film adhesive 46 is utilized, it will be wrapped around engagement portion 38 prior to insertion of engagement portion into channel 30. Once the adhesive is in place, the components are pressed together in the direction indicated by arrows 45 and 47.

[0036] FIG. 6. is an expanded cross-sectional view of the joint formed between lower panel 14 and web section 16 after engagement portion 38 (see FIG. 5) is snap-fit into engagement with channel 30. In this view, an adhesive layer 48 can be observed in the joint. Adhesive layer 48 may be comprised of either liquid adhesive 44 or film adhesive 46, or a combination thereof. By disposing adhesive layer 48 around three sides of engagement portion 38 (see FIG. 5), a very robust coupling can be achieved between web section 16 and lower panel 14, thus obviating the need for mechanical fasteners.

[0037] FIG. 7 is a flow diagram illustrating an embodiment of a method 60 for making an aircraft component in accordance with the teachings of the present disclosure. With continuing reference to FIGS. 1-6, at step 62, an upper panel, a lower panel, and a web section such as, but not limited to, upper panel 12, lower panel 14, and web section 16, respectively, are obtained.

[0038] In some embodiments of method 60, these components may obtained from a supplier while in other embodiments, these components may be fabricated as part of making the aircraft component. To fabricate the panels and web sections, obtain three billets of

material (e.g., aluminum), one billet corresponding to the upper panel, one billet corresponding to the lower panel, and one billet corresponding to the web section. Each billet of material may have a thickness that is only slightly thicker than the desired final thickness of the completed component that it corresponds to.

[0039] Once the three billets of material have been obtained, remove material from each billet to reduce its thickness to the desired thickness of the finished upper panel, lower panel, and web section, respectively. In some embodiments, it may be desirable to machine each billet in order to reduce its thickness. In other embodiments, the material may be removed from the billet in any other suitable manner.

[0040] Once the desired thickness for each billet has been reached, form one or more channels on two of the billets. In embodiments where the channels will protrude above the surface of the panel, the channels may be formed when the thickness of each billet is reduced. In other embodiments where the channels will be located below the surface of the panel, additional material will be removed from the billet after its desired thickness has been obtained. On the third billet, modify its end portions to form engagement portions. In some embodiments, this may entail adding a barb along opposite edges of the billet.

[0041] Once the upper panel, lower panel, and web section have been obtained, at step 64, an adhesive is applied to the joint that couples the upper and lower panels to the web section. In some embodiments, this may entail squeezing a liquid adhesive into the channel. In other embodiments, a film adhesive may be wrapped around the engagement portions of the web section. In some embodiments, the adhesive may be applied along the entire length of the channel/engagement portion while in other embodiments, it may be sufficient to apply the adhesive along a length less than the entire length of the channel/engagement portion.

[0042] At step 66, the upper panel, the lower panel, and the web section are aligned with one another prior to snap-fit engagement. In some embodiments, this step requires that the components be placed in a press. The upper panel and the lower panel will be positioned in the press such that their respective channels are disposed opposite one another. The web section is positioned such that its engagement portions are positioned adjacent the channels of the upper and lower panels. In some embodiments, prior to compressing the components together, the engagement portions may partially engage the channels of the upper and lower

panel such that the components may independently maintain their final configuration without the assistance of external or additional bracing structures.

[0043] At step 68, the components are compressed together to cause the engagement portions of the web section to engage the channels of the upper and lower panel in a snap-fit manner. In some embodiments, this may be accomplished using a press while in other embodiments, it may be possible to compress the components together by hand.

[0044] Once the components have been snap-fit together, assembly of the aircraft component is complete. The aircraft component may be removed from the press without delay because the snap-fit features (or other type of engagement feature) enable the components to remain attached together without having to wait until the adhesive cures. This feature permits a shorter cycle time than would be required if the aircraft component lacked the snap-fit/engagement features of the aircraft component disclosed herein because a conventional aircraft component would need to remain in the press for a longer period of time while the adhesive cures.

[0045] While at least one exemplary embodiment has been presented in the foregoing detailed description of the disclosure, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention. It being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope of the disclosure as set forth in the appended claims.

CLAIMS

What is claimed is:

1. An aircraft component comprising:

a first panel including a first channel;

a second panel including a second channel, the second panel positioned such that the second channel is aligned with the first channel;

a web section disposed adjacent the first panel and the second panel, the web section including a first engagement portion and a second engagement portion, the first engagement portion engaged with the first channel and the second engagement portion engaged with the second channel; and

an adhesive disposed between the first engagement portion and the first channel and between the second engagement portion and the second channel,

wherein the first panel and the second panel are joined together by cooperation of the web section and the adhesive.

2. The aircraft component of claim 1, wherein the first engagement portion and the first channel are configured to snap-fit together and wherein the second engagement portion and the second channel are configured to snap-fit together.

3. The aircraft component of claim 2, wherein the first engagement portion includes a first barb extending along a length of the first engagement portion, the first channel comprises a first lip extending along a length of the first channel, and the first lip is configured to engage the first barb when the first engagement portion is inserted into the first channel, and

wherein the second engagement portion includes a second barb extending along a length of the second engagement portion, the second channel comprises a second lip extending along a length of the second channel, and the second lip is configured to engage the second barb when the second engagement portion is inserted into the second channel.

4. The aircraft component of claim 1, wherein the aircraft component is substantially free of any fasteners.

5. The aircraft component of claim 1, wherein the first panel is disposed opposite the second panel and wherein the web section is disposed between the first panel and the second panel.

6. The aircraft component of claim 1, wherein the first panel includes a plurality of the first channels, wherein the second panel includes a respective plurality of the second channels, the aircraft component further comprising a respective plurality of the web sections, wherein each web section is engaged with a respective first channel and a respective second channel, and wherein the adhesive is disposed between each first engagement portion of each web section and each respective first channel and between each second engagement portion of each web section and each respective second channel.

7. The aircraft component of claim 6, wherein one first channel of the plurality of first channels is out of alignment with another first channel of the plurality of first channels, wherein one second channel of the plurality of second channels is out of alignment with another second channel of the plurality of second channels, and wherein the one first channel is aligned with the one second channel.

8. The aircraft component of claim 1, wherein the adhesive is engaged with three sides of the first engagement portion and with three sides of the second engagement portion.

9. The aircraft component of claim 1, wherein the adhesive comprises a liquid adhesive.

10. The aircraft component of claim 1, wherein the adhesive comprises a film adhesive.

11. The aircraft component of claim 1, wherein the first panel, the second panel, and the web section each comprise a metal material.

12. The aircraft component of claim 11, wherein the metal material comprises aluminum.

13. A method of making an aircraft component, the method comprising the steps of:

obtaining a first panel having a first channel, a second panel having a second channel, and a web section having a first engagement portion and a second engagement portion;

applying an adhesive to one of the first engagement portion and the first channel and to one of the second engagement portion and the second channel;

positioning the first panel, the second panel, and the web section such that the first engagement portion is disposed adjacent the first channel and such that the second engagement portion is disposed adjacent the second channel;

compressing the first panel, the second panel, and the web section until the first engagement portion engages the first channel and the second engagement portion engages the second channel to form the aircraft component.

14. The method of claim 13, wherein the obtaining step comprises:

obtaining at least three billets of material;

removing material from a first billet to produce a first subcomponent having a first desired thickness;

removing material from a second billet to produce a second subcomponent having a second desired thickness;

removing material from a third billet to produce a third subcomponent having a third desired thickness;

defining a first channel in the first subcomponent to form the first panel;

defining a second channel in the second subcomponent to form the second panel;

defining a first engagement portion and a second engagement portion on the third subcomponent to form a web section.

15. The method of claim 14, wherein the obtaining step comprises:

obtaining a first billet of material having a first initial thickness that is insubstantially thicker than the first desired thickness;

obtaining a second billet of material having a second initial thickness that is insubstantially thicker than the second desired thickness; and

obtaining a third billet of material having a third initial thickness that is insubstantially thicker than the third desired thickness.

16. The method of claim 14, wherein removing material from the first billet comprises machining the first billet, wherein removing material from the second billet comprises machining the second billet, and wherein removing material from the third billet comprises machining the third billet.

17. The method of claim 14, wherein defining the first channel comprises defining a first pair of engaging lips, wherein defining the second channel comprises defining a second pair of engaging lips, wherein defining the first engagement portion comprises defining a first barb along a first edge of the third subcomponent, and wherein defining the second engagement portion comprises defining a second barb along a second edge of the third subcomponent.

18. The method of claim 13, wherein the compressing step comprises compressing the first panel, the second panel, and the web section in a press.

19. The method of claim 18, wherein the aircraft component is removed from the press before the adhesive cures.

20. The method claim of claim 13, wherein the first engagement portion includes a first barb configured for snap-fit engagement with the first channel, wherein the second engagement portion includes a second barb configured for snap-fit engagement with the second channel, and wherein the compressing step comprises compressing the first panel, the second panel, and the web section until the first engagement portion and the first channel snap together and until the second engagement portion and the second channel snap together.

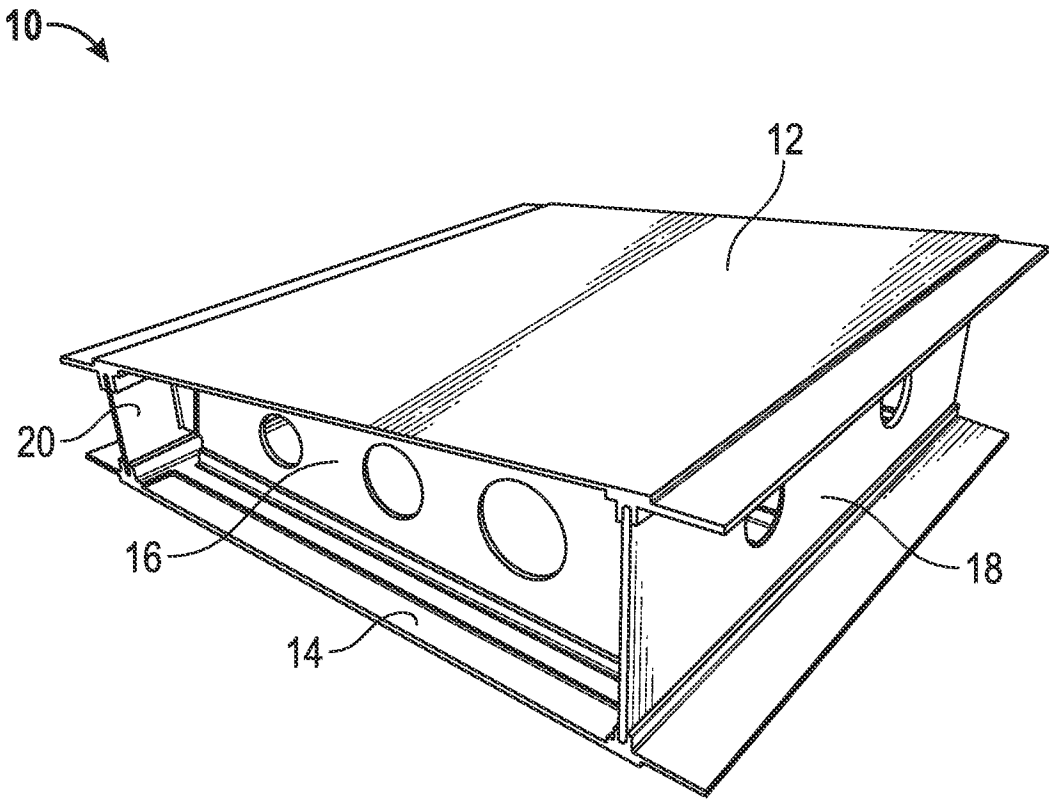


FIG. 1

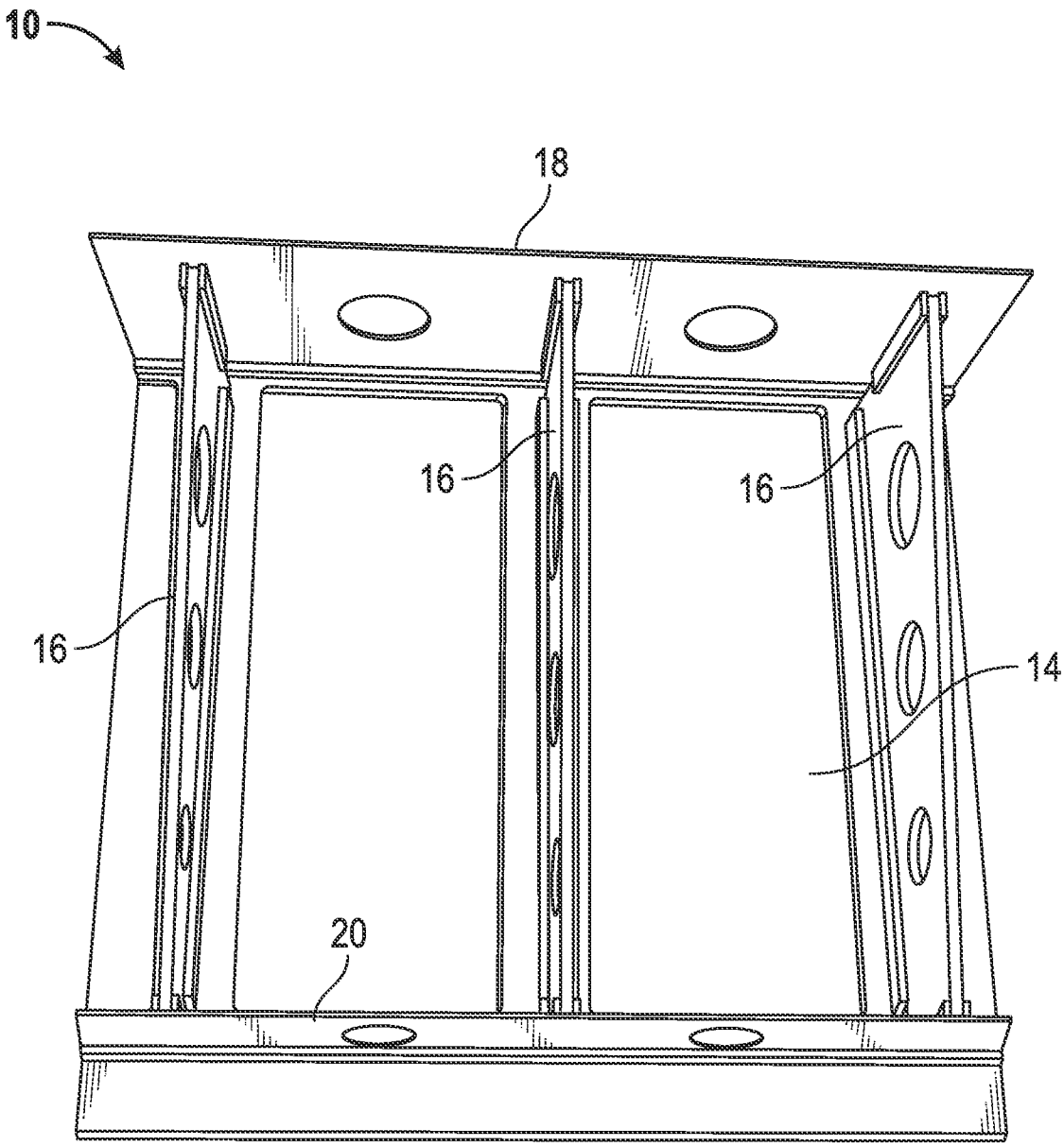


FIG. 2

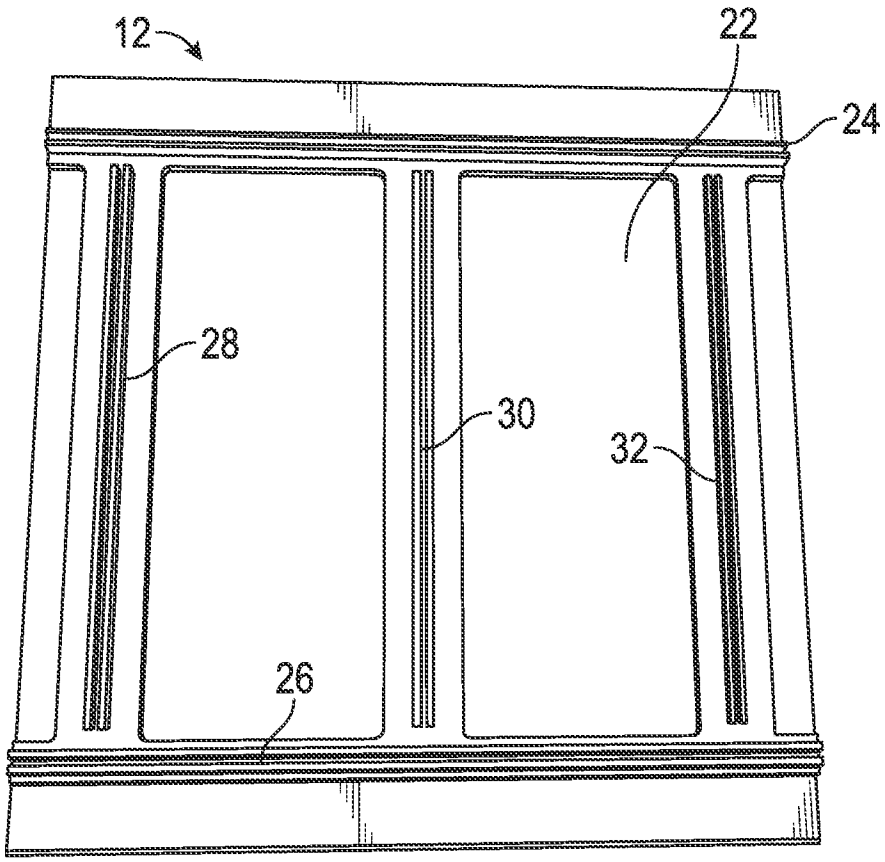


FIG. 3

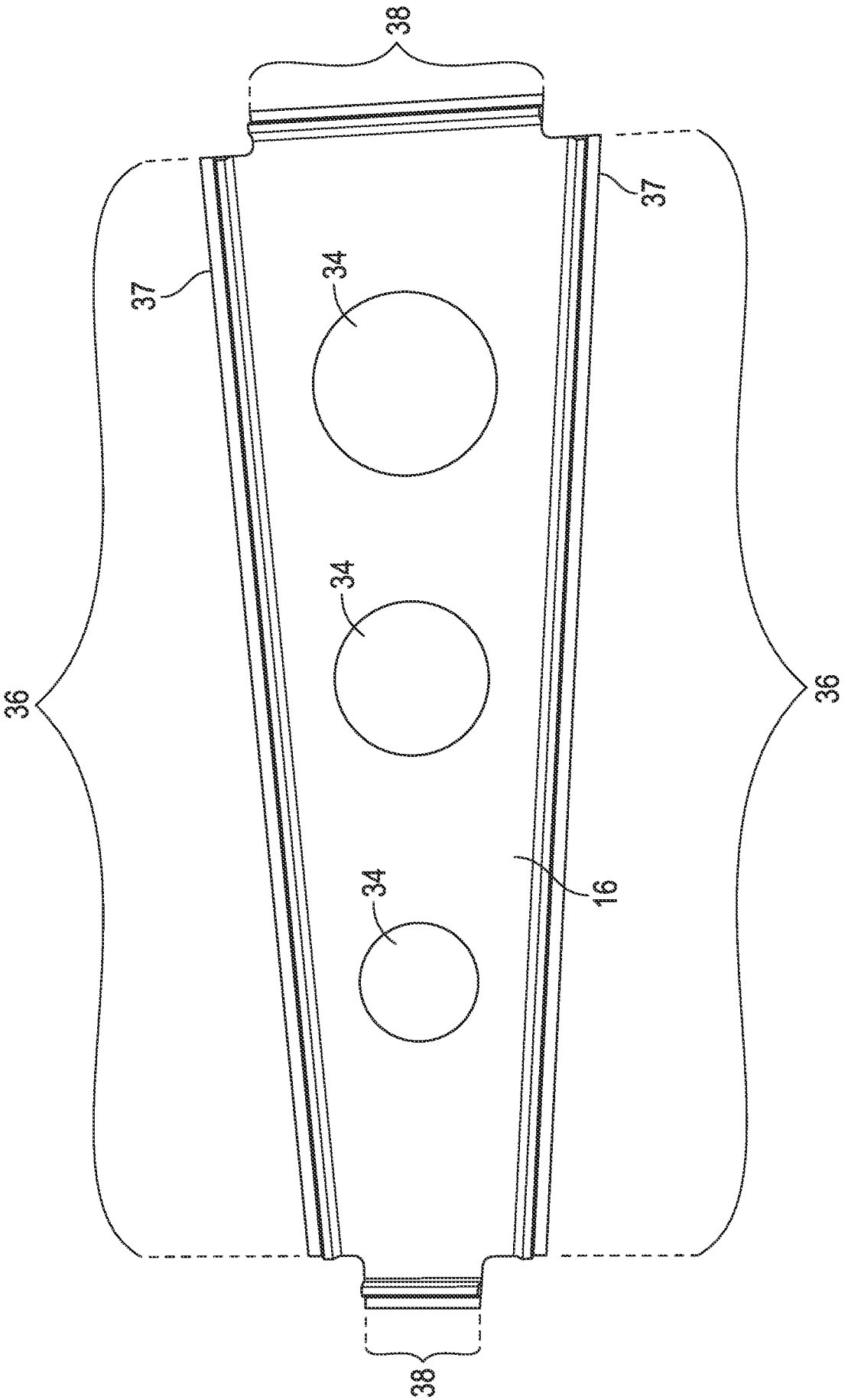


FIG. 4

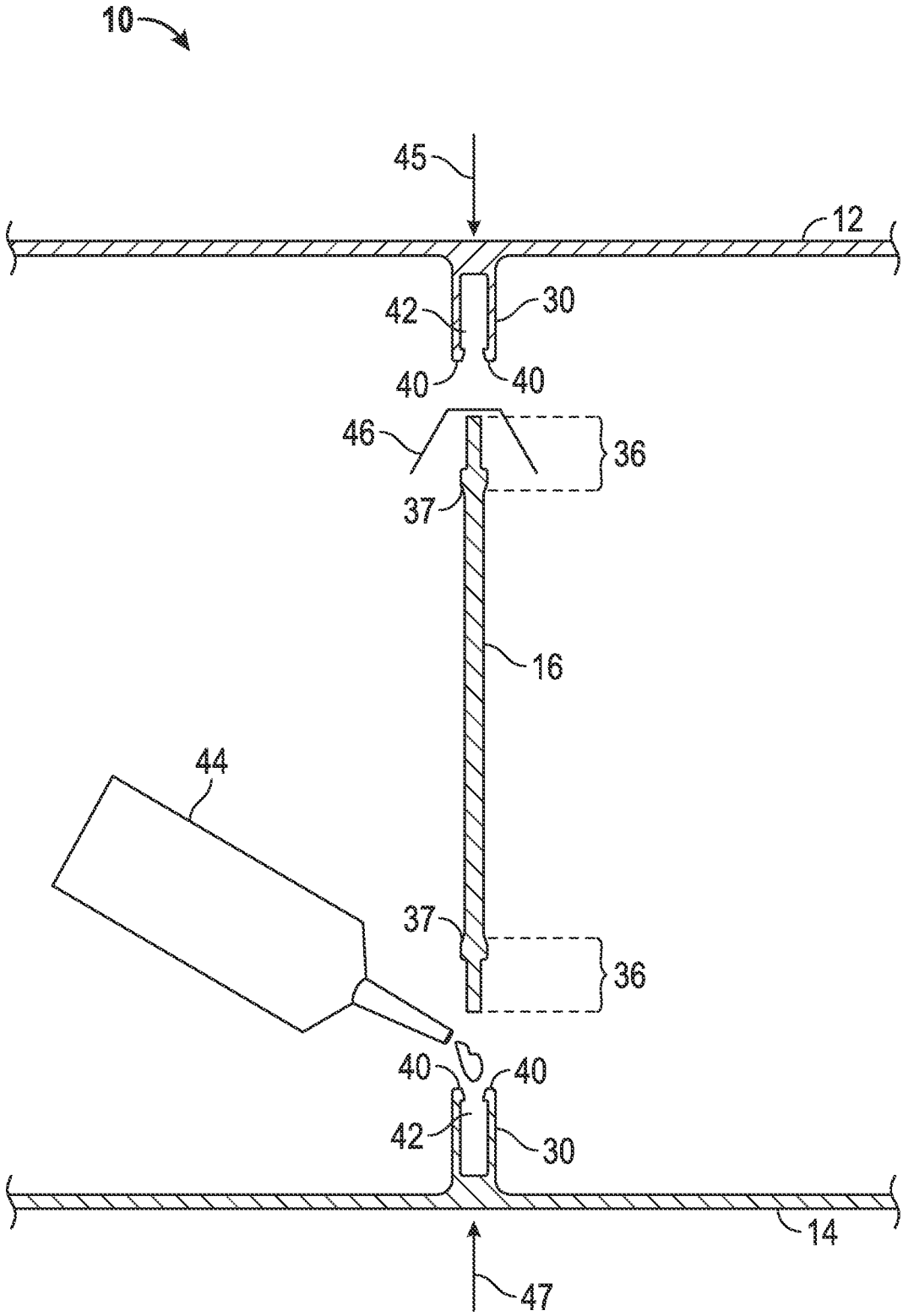


FIG. 5

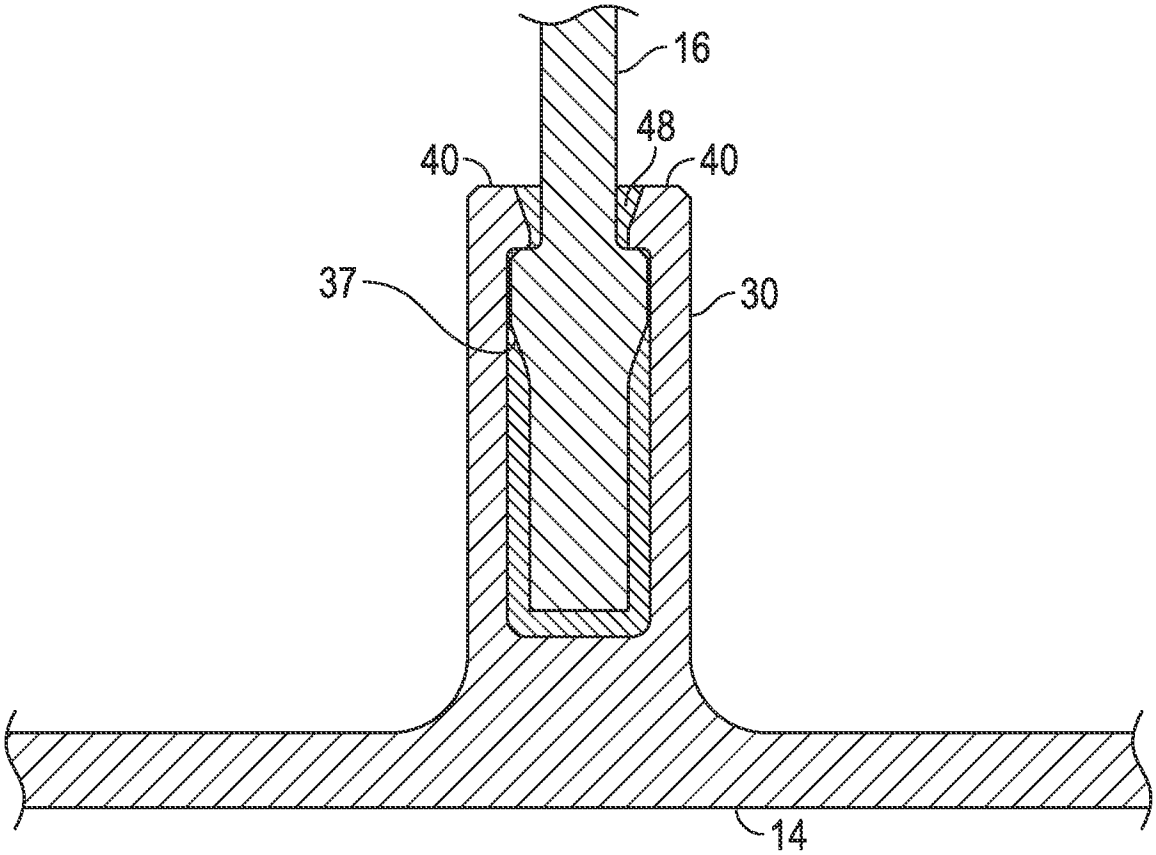


FIG. 6

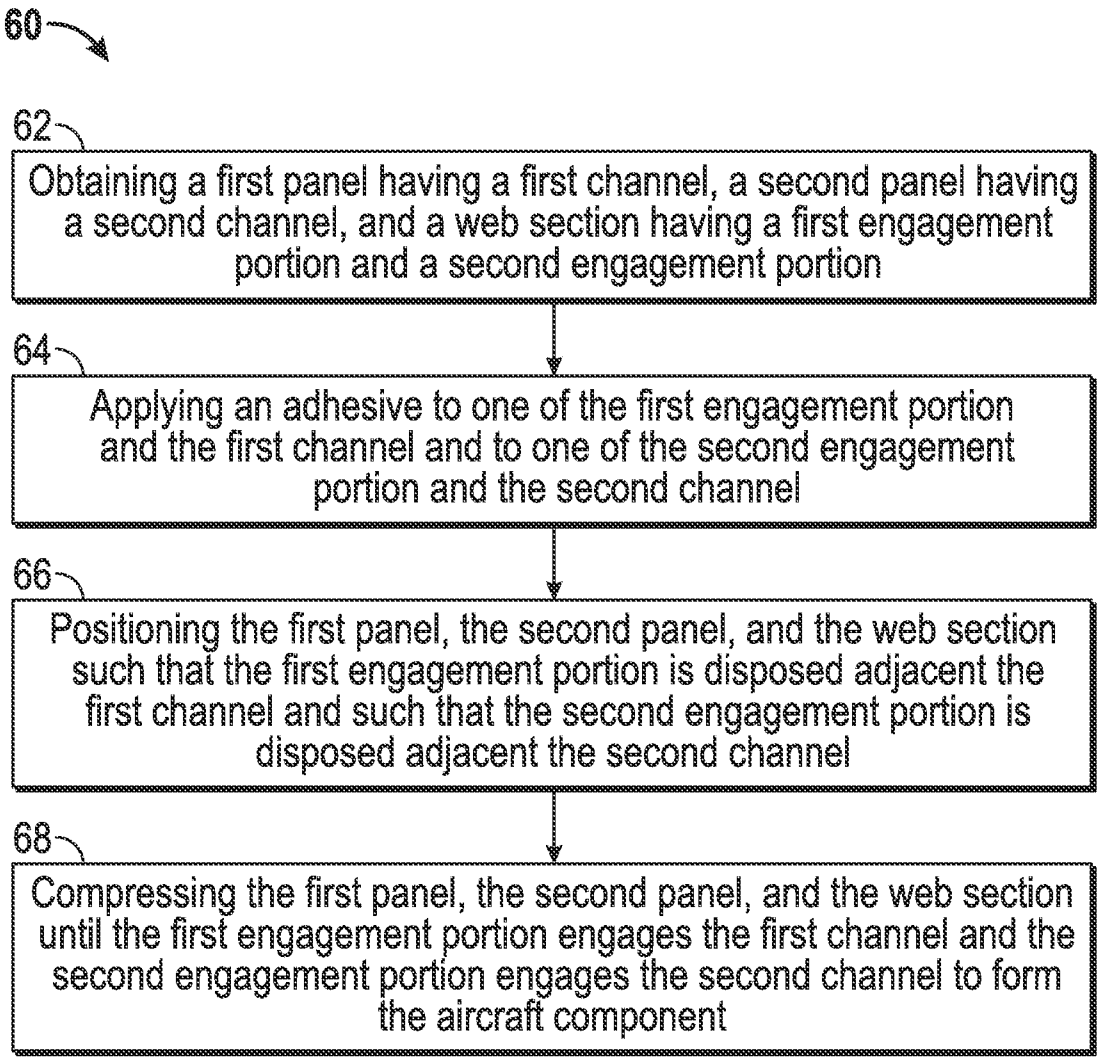

60
62
Obtaining a first panel having a first channel, a second panel having a second channel, and a web section having a first engagement portion and a second engagement portion
64
Applying an adhesive to one of the first engagement portion and the first channel and to one of the second engagement portion and the second channel
66
Positioning the first panel, the second panel, and the web section such that the first engagement portion is disposed adjacent the first channel and such that the second engagement portion is disposed adjacent the second channel
68
Compressing the first panel, the second panel, and the web section until the first engagement portion engages the first channel and the second engagement portion engages the second channel to form the aircraft component

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/020663

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B64C 1/12 (2014.01)
USPC - 244/123.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B64C 1/06, 1/12, 1/26, 3/18; F16B 11/00 (2014.01)
USPC - 52/281; 156/293, 304.1; 244/123.1, 131, 132; 403/109.8, 345, 375, 381

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - B64C 1/06, 1/12, 3/18; F16B 11/006 (2014.02)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2,807,437 A (ROUSH) 24 September 1957 (24.09.1957) entire document	1, 4-7, 11-13 --- 2-3, 8-10, 14-18, 20
Y	US 2004/0011927 A1 (CHRISTMAN et al) 22 January 2004 (22.01.2004) entire document	2-3, 17, 20
Y	US 7,238,409 B1 (PETERSON et al) 03 July 2007 (03.07.2007) entire document	8-10
Y	US 2006/0113450 A1 (KILWIN et al) 01 June 2006 (01.06.2006) entire document	14-17
Y	US 2002/0195524 A1 (AMAOKA et al) 26 December 2002 (26.12.2002) entire document	18
A	US 4,671,470 A (JONAS) 09 June 1987 (09.06.1987) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 June 2014	23 JUN 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774