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United States Patent	12384517
Kind Code	B2
Date of Patent	August 12, 2025
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Aircraft wing unit with pressure fence

Abstract

Assemblies and methods for facilitating the assembly of aircraft wings to a fuselage are disclosed. In some embodiments, a wing unit includes features that are configured to define one of more parts of a pressure vessel that is partially defined by the fuselage portion. In some embodiments, the aircraft assemblies disclosed herein comprise one or more first structural interfaces that permit positional adjustment between the wing unit and the fuselage portion so that one or more second structural interfaces may be finished only after such positional adjustment. In some embodiments, the aircraft assemblies disclosed herein comprise one or more structural interfaces that are disposed outside of the wing unit in order to eliminate or reduce the need for assembly personnel to access the interior of the wing unit to carry out the structural assembly of the wing unit to the fuselage portion.

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Appl. No.: **18/398013**

Filed: **December 27, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20240124120 A1	Apr. 18, 2024

Related U.S. Application Data

continuation parent-doc US 16608978 US 11891173 WO PCT/IB2018/052906 20180426 child-doc US 18398013

Publication Classification

Int. Cl.: **B64C3/58** (20060101); **B64C1/06** (20060101); **B64C1/26** (20060101); **B64F5/10** (20170101)

U.S. Cl.:

CPC **B64C3/58** (20130101); **B64C1/26** (20130101); **B64F5/10** (20170101); B64C1/06 (20130101)

Field of Classification Search

CPC: B64C (1/26); B64C (3/58); B64C (1/06); B64F (5/10)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) (1) This application is a Continuation of U.S. patent application Ser. No. 16/608,978 filed Oct. 28, 2019, which was a national phase application under 35 U.S.C. 371 of International PCT Patent Application No. PCT/IB2018/052906 filed on Apr. 26, 2018, which relies for priority on U.S. Provisional patent application Ser. No. 62/492,583 filed on May 1, 2017, the entire contents of each of which are incorporated herein by reference.

TECHNICAL FIELD
(1) The disclosure relates generally to aircraft, and more particularly to the assembly of aircraft.
BACKGROUND
(2) Fixed wing aircraft typically comprise two wings that are attached to a fuselage via a central wing box which defines a load path between the wings and the fuselage. The number of parts needed for assembling the wings to the fuselage via the wing box can be relatively high and the associated assembly operations, which take place on the final assembly line, can be time consuming. Some of the operations associated with assembling the wings to the fuselage can require assembly personnel to have to physically access the space inside the wings in order to perform some of the assembly operations from inside the wings. For some aircraft, the space inside of the wings is relatively small and this can limit the number of individuals that can work on assembling the wings to the fuselage at the same time and this can influence the total assembly time.
SUMMARY
(3) In one aspect, the disclosure describes an aircraft wing unit for assembly with a fuselage portion of an aircraft. The wing unit comprises: a first wing configured to extend in a first lateral direction relative to the fuselage portion and a second wing configured to extend in an opposite second lateral direction relative to the fuselage portion, the first wing and the second wing being attached together; a first pressure fence attached to the first wing; and a second pressure fence attached to the second wing; wherein: the first wing, the first pressure fence, the second wing and the second pressure fence together define the wing unit for assembly with the fuselage portion; the first pressure fence is configured to interface with the fuselage portion and define a first part of a pressure vessel partially defined by the fuselage portion when the wing unit is assembled with the fuselage portion; and the second pressure fence is configured to interface with the fuselage portion and define a second part of the pressure vessel partially defined by the fuselage portion when the wing unit is assembled with the fuselage portion.
(4) The first pressure fence and the second pressure fence may cooperatively define a cradle for receiving part of the fuselage portion.
(5) The first pressure fence may comprise a first fence skin and the second pressure fence may comprise a second fence skin. The first fence skin may extend upwardly relative to an upper skin of the first wing and also in the first lateral direction. The second fence skin may extend upwardly relative to an upper skin of the second wing and also in the second lateral direction.
(6) An upper portion of the first fence skin and an upper portion of the second fence skin may each be configured to interface with one or more structural members of the fuselage portion.
(7) The first pressure fence may comprise one or more first fence frames and the second pressure fence may comprise one or more second fence frames. The one or more first fence frames and the one or more second fence frames may be configured to be attached to respective fuselage frames.
(8) Embodiments may include combinations of the above features.
(9) In another aspect, the disclosure describes an aircraft structural assembly comprising: a fuselage portion partially defining a pressure vessel containing a passenger cabin including a cabin floor;

and a wing unit attached to the fuselage portion, the wing unit comprising: a first wing extending in a first lateral direction relative to the fuselage portion and a second wing extending in an opposite second lateral direction relative to the fuselage portion; a first pressure fence attached to the first wing, the first pressure fence defining a first part of the pressure vessel partially defined by the fuselage portion, the first pressure fence being attached to the fuselage portion at a first joining location that is disposed vertically above the cabin floor; and a second pressure fence attached to the second wing, the second pressure fence defining a second part of the pressure vessel partially defined by the fuselage portion, the second pressure fence being attached to the fuselage portion at a second joining location that is disposed vertically above the cabin floor.

(10) The first pressure fence and the second pressure fence may cooperatively define a cradle into which part of the fuselage portion is received.

(11) The first pressure fence may comprise a first fence skin and the second pressure fence may comprise a second fence skin. The first fence skin may extend upwardly relative to an upper wing skin of the first wing and also in the first lateral direction. The second fence skin may extend upwardly relative to the upper wing skin of the second wing and also in the second lateral direction.

(12) An upper portion of the first fence skin may be attached to a first stringer of the fuselage portion and an upper portion of the second fence skin may be attached to a second stringer of the fuselage portion. The first and second stringers may be disposed vertically above the cabin floor of the fuselage portion.

(13) The first pressure fence may comprise one or more first fence frames and the second pressure fence may comprise one or more second fence frames. The one or more first fence frames and the one or more second fence frames may be attached to respective fuselage frames. The one or more first fence frames and the one or more second fence frames may extend vertically above the cabin floor of the fuselage portion.

(14) A portion of the upper wing skin defined by the first wing and the second wing may define a third part of the pressure vessel partially defined by the fuselage portion.

(15) The first pressure fence may comprise a first fence skin and the second pressure fence may comprise a second fence skin. The first pressure fence may comprise one or more first fence frames supporting the first fence skin. The second pressure fence may comprise one or more second fence frames supporting the first fence skin. The one or more first fence frames and the one or more second fence frames may be attached to respective fuselage frames.

(16) The first pressure fence may comprise a first fence skin and the second pressure fence may comprise a second fence skin. The first fence skin and second fence skin may respectively overlap one or more fuselage frames.

(17) An upper skin portion of the wing unit may define a third part of the pressure vessel partially defined by the fuselage portion.

(18) Embodiments may include combinations of the above features.

(19) In another aspect, the disclosure describes a method for producing an aircraft structural assembly using a fuselage portion partially defining a pressure vessel and an assembled wing unit where the wing unit comprises: a first wing extending in a first lateral direction relative to the fuselage portion and a second wing extending in an opposite second lateral direction relative to the fuselage portion; a first pressure fence attached to the first wing; and a second pressure fence attached to the second wing. The method comprises: assembling the wing unit with the fuselage portion so that the first pressure fence defines a first part of the pressure vessel partially defined by the fuselage portion and the second pressure fence defines a second part of the pressure vessel partially defined by the fuselage portion.

(20) The method may comprise receiving part of the fuselage portion into a cradle cooperatively defined by the first pressure fence and the second pressure fence of the wing unit.

(21) The method may comprise: attaching the first pressure fence to the fuselage portion at a first joining location that is disposed vertically above a cabin floor of the fuselage portion; and attaching

the second pressure fence to the fuselage portion at a second joining location that is disposed vertically above the cabin floor of the fuselage portion.
(22) The method may comprise: attaching a first fence skin of the first pressure fence to a first stringer of the fuselage portion, the first stringer being disposed vertically above a cabin floor of the fuselage portion; and attaching a second fence skin of the second pressure fence to a second stringer of the fuselage portion, the second stringer being disposed vertically above the cabin floor of the fuselage portion.
(23) The method may comprise: attaching a first fence frame of the first pressure fence to a first fuselage frame of the fuselage portion at a first joining location disposed vertically above the cabin floor of the fuselage portion; and attaching a second fence frame of the second pressure fence to a second fuselage frame of the fuselage portion at a second joining location disposed vertically above the cabin floor of the fuselage portion.
(24) The method may comprise: receiving a first portion of the wing unit comprising the first wing and the first pressure fence; receiving a second portion of the wing unit comprising the second wing and the second pressure fence; and attaching the first and second portions of the wing unit together before assembling the aircraft wing unit with the fuselage portion.
(25) Embodiments may include combinations of the above features.
(26) In another aspect, the disclosure describes a method for producing an aircraft wing unit for assembly with a fuselage portion of an aircraft. The method comprises: assembling a first portion of the wing unit including: a first wing configured to extend in a first lateral direction relative to the fuselage portion of the aircraft; and a first pressure fence configured to define a first part of a pressure vessel partially defined by the fuselage portion; assembling a second portion of the wing unit including: a second wing configured to extend in a second lateral direction relative to the fuselage portion of the aircraft; and a second pressure fence configured to define a second part of the pressure vessel partially defined by the fuselage portion; and finishing an interface for assembling the first portion of the wing unit with the second portion of the wing unit prior to assembling the wing unit with the fuselage portion of the aircraft.
(27) The method may comprise: finishing the interface at a first facility; and then shipping the first portion of the aircraft wing unit and the second portion of the aircraft wing unit to a second facility prior to assembling the first and second portions of the wing unit together.
(28) The method may comprise: positioning the first wing and the second wing in their respective in-use configurations relative to each other; and while the first wing and the second wing are in their respective in-use configurations relative to each other, finishing the interface for assembling the first portion of the aircraft wing unit with the second portion of the aircraft wing unit.
(29) The method may comprise: positioning the first wing and the second wing in their respective in-use configurations relative to each other; and while the first wing and the second wing are in their respective in-use configurations relative to each other, assembling the first pressure fence to the first portion of the aircraft wing unit and assembling the second pressure fence to the second portion of the aircraft wing unit.
(30) The method may comprise, while the first wing and the second wing are in their respective in-use configurations relative to each other, finishing the interface for assembling the first portion of the aircraft wing assembly with the second portion of the aircraft wing assembly.
(31) The method may comprise: assembling the first portion of the wing unit with the second portion of the wing unit; and then assembling the wing unit with the fuselage portion of the aircraft.
(32) Embodiments may include combinations of the above features.
(33) In a further aspect, the disclosure describes an aircraft comprising an assembly as disclosed herein.
(34) In a further aspect, the disclosure describes an aircraft comprising a wing unit as disclosed herein.

(35) Further details of these and other aspects of the subject matter of this application will be apparent from the detailed description included below and the drawings.

Description

DESCRIPTION OF THE DRAWINGS

(1) Reference is now made to the accompanying drawings, in which:

(2) FIG. **1** is a top plan view of an exemplary aircraft comprising a wing unit as described herein;

(3) FIG. **2** is a perspective view of the wing unit and a fuselage portion of the aircraft of FIG. **1** in the process of being assembled together;

(4) FIG. **3** is a partial perspective view of the wing unit prior to assembly with the fuselage portion;

(5) FIG. **4** is a partial perspective view of a first portion of the wing unit;

(6) FIG. **5**A is a partial perspective view of the wing unit showing an interior of the wing unit;

(7) FIG. **5**B is an enlarged perspective cross-sectional view of an exemplary seam in an upper wing skin of the wing unit;

(8) FIG. **5**C is an enlarged perspective cross-sectional view of an exemplary seam in a lower wing skin of the wing unit;

(9) FIG. **6** is a flowchart illustrating an exemplary method for producing the wing unit;

(10) FIGS. **7**A and **7**B graphically illustrate an exemplary method for producing an aircraft structural assembly using the fuselage portion and the wing unit;

(11) FIG. **8** is an axial cross-sectional view through the fuselage portion and the wing unit;

(12) FIG. **9** is a perspective view of the axial cross-section through the fuselage portion and the wing unit;

(13) FIG. **10** is perspective view of an aft portion of the wing unit assembled with the fuselage portion;

(14) FIG. **11**A is a perspective view showing an exemplary aft tension fitting of the wing unit permitting relative positional adjustment between the wing unit and the fuselage portion;

(15) FIG. **11**B is a perspective view showing the aft tension fitting of FIG. **11**A in a fully assembled configuration;

(16) FIG. **12**A is a perspective view of an exemplary joint between a pressure fence of the wing unit and the fuselage portion;

(17) FIG. **12**B is a perspective cross-sectional view taken along line **12-12** of FIG. **12**A;

(18) FIG. **13** is a perspective cross-sectional view through another exemplary joint between the pressure fence of the wing unit and the fuselage portion;

(19) FIG. **14** is a perspective view showing an exemplary forward tension fitting of the wing unit for attaching the wing unit to the fuselage portion;

(20) FIG. **15** is a perspective view of an exemplary upper wing skin portion of the wing unit in relation to floor beams of the fuselage portion;

(21) FIG. **16** is a perspective view of an exterior of the pressure fence when the wing unit and the fuselage portion are assembled together; and

(22) FIG. **17** is a flowchart illustrating an exemplary method for assembling the wing unit with the fuselage portion.

DETAILED DESCRIPTION

(23) In various embodiments, the present disclosure discloses assemblies and methods that facilitate the assembly of aircraft. For example, aircraft wing assemblies that can be assembled as a unit (i.e., single-piece wing) with a fuselage portion of an aircraft, and associated methods are disclosed. In some embodiments, such a wing unit can include features that are configured to define one of more parts of a pressure vessel that is partially defined by the fuselage portion. In some embodiments, the aircraft assemblies disclosed herein comprise one or more first structural

interfaces that permit positional (e.g., aerodynamic) adjustment between the wing unit and the fuselage portion so that one or more second structural interfaces may be finished only after such positional adjustment and while the wing unit is attached to the fuselage portion via the first structural interface. In some embodiments, the aircraft assemblies disclosed herein comprise one or more structural interfaces that are disposed outside of the wing unit in order to eliminate or reduce the need for assembly personnel to access the interior of the wing unit to carry out the structural assembly of the wing unit to the fuselage portion. This may facilitate the assembly process and also permit several individuals to work on the assembly process simultaneously in order to reduce the overall assembly time.

(24) Aspects of various embodiments are described through reference to the drawings.

(25) FIG. **1** is a top plan view of an exemplary aircraft **10** which may comprise wing unit **12** and which may be assembled using one or more methods disclosed herein. Aircraft **10** may, for example, be any type of aircraft such as corporate (e.g., business jet), private, commercial and passenger aircraft suitable for civil aviation. For example, aircraft **10** may be a long-range business jet having relatively thin wings **14**A, **14**B (referred generally as "wings **14**") and hence with relatively little space inside wings **14** for access by assembly personnel. Aircraft may be a fixed-wing aircraft.

(26) Aircraft **10** may comprise flight control surfaces **16** (e.g., flaps, slats, ailerons, spoilers, elevator(s), rudder(s)), fuselage **18**, one or more engines **20** and empennage **22**. One or more of flight control surfaces **16** may be mounted to wings **14**. One or more of engines **20** may be mounted to fuselage **18**. Alternatively, or in addition, one or more of engines **20** may be mounted to wings **14**. Aircraft **10** may have a longitudinal axis LA extending through fuselage **18** from tail to nose in the normal direction of flight, or the direction the pilot faces. Longitudinal axis LA may correspond to a roll axis of aircraft **10**.

(27) FIG. **2** is a perspective view of wing unit **12** and fuselage portion **18**A of aircraft in the process of being assembled together. Fuselage portion **18**A may be a mid-fuselage portion of aircraft **10** and may define part of a pressure vessel comprising a passenger cabin of aircraft **10**. During assembly, fuselage portion **18**A may be supported by fuselage supports **24** and wing unit **12** may be supported by wing supports **26**. In some embodiments, wing supports **26** may be controllably actuated so that wing unit **12** may be moved (e.g., raised) relative to fuselage portion **18**A in order to bring wing unit **12** and fuselage portion **18**A together for assembly. Alternatively or in addition, fuselage supports **24** may be controllably actuated so that fuselage portion **18**A may be moved (e.g., lowered) relative to wing unit **12** in order to bring wing unit **12** and fuselage portion **18**A together for assembly.

(28) FIG. **3** is a partial perspective view of wing unit **12** prior to assembly with fuselage portion **18**A. Wing unit **12** may comprise an assembly of parts that can be assembled separately from fuselage unit **18**A and subsequently be assembled as a pre-assembled unit with fuselage portion **18**A in order to facilitate assembly of aircraft **10**. For the sake of clarity, some details of wing unit **12** including flight control surfaces **16** have been omitted from some figures herein. It is understood that in some embodiments, wing unit **12** may additionally comprise one or more flight control surfaces **16** that may be coupled to or form part of wings **14** before the attachment of wing unit **12** to fuselage portion **18**A. Alternatively, one or more flight control surfaces **16** may be attached to wing unit **12** only after wing unit **12** has been attached to fuselage portion **18**A.

(29) Wing unit **12** may comprise wing **14**A configured to extend in a first lateral direction (e.g., port side) relative to fuselage portion **18**A and wing **14**B configured to extend in an opposite second lateral direction (e.g., starboard side) relative to fuselage portion **18**A. Wings **14**A and **14**B may define a wingspan of aircraft **10** as shown in FIG. **1**. Wings **14**A and **14**B may be attached together at an intermediate portion **30** of wing unit **12**. Intermediate portion **30** of wing unit **12** may define a wing box for interfacing with fuselage portion **18**A but that is part of wing unit **12** for assembly with fuselage portion **18**A.

(30) Wing unit **12** may comprise pressure fence **28**A attached to wing **14**A and pressure fence **28**B attached to wing **14**B. Pressure fence **28**A may be disposed at or near a root of wing **14**A. Similarly, pressure fence **28**B may be disposed at or near a root of wing **14**B. Pressure fences **28**A, **28**B may be configured to interface with fuselage portion **18**A and respectively define parts of the pressure vessel partially defined by fuselage portion **18**A when wing unit **12** is assembled with fuselage portion **18**A.
(31) FIG. **4** is a partial perspective view of first portion **12**A of the wing unit **12**. In some embodiments, wing unit **12** may be manufactured as two portions (e.g., counterparts or halves) that are subsequently assembled together at upper seam **32** formed in upper wing skin portion **34** defined by wings **14** and at lower seam **36** formed in lower wing skin **38** defined by wings **14**. For example, first portion **12**A and a substantially similar second portion **12**B (shown in FIG. **3**) may be fabricated at a first facility (e.g., a supplier's facility) and shipped to an aircraft manufacturer's facility where both portions **12**A, **12**B may then be assembled together to form wing unit **12**, and then, wing unit **12** may subsequently be assembled with fuselage portion **18**A. First portion **12**A and second portion **12**B may not necessarily be identical. For example, some components such as middle rib **40**, forward keel beam fitting **42** and aft keel beam fitting **44** may be unique within wing unit **12** and accordingly may be disposed on only one or the other of first portion **12**A and second portion **12**B of wing unit **12**. In some embodiments, upper seam **32** in upper wing skin portion **34** may follow a curvature of upper wing skin portion **34** and may lie in a (e.g., vertical) plane that is substantially parallel to longitudinal axis LA. In some embodiments, upper seam **32** may be disposed at a mid-point along a wingspan of wing unit **12**. In some embodiments, upper seam **32**, lower seam **36** and longitudinal axis LA may lie in a common vertical plane.
(32) In some embodiments, upper wing skin portion **34** may define part of the pressure vessel partially defined by fuselage portion **18**A and may comprise relatively few seams so as to provide relatively few potential leak paths. Upper wing skin portion **34** may extend partially or substantially entirely between a forward portion of wing unit and an aft portion of wing unit **12** (e.g., between a front spar and an aft spar of wing unit **12**). In some embodiments, upper wing skin portion **34** partially defining the pressure vessel may comprise only one single upper seam **32**, which may be a longitudinal seam. For example, the entirety of upper wing skin portion **34** that partially defines the pressure vessel may be free of any transverse seams relative to longitudinal axis LA.
(33) In some embodiments, pressure fences **28**A, **28**B may be mirror images of each other and may have substantially identical constructions so the following description of pressure fence **28**A also applies to pressure fence **28**B. However, it is understood that pressure fences **28**A and **28**B may not necessarily be identical. Pressure fence **28**A may comprise fence skin **46** supported by one or more fence frames **48**. Fence skins **46** of each pressure fence **28**A, **28**B may extend upwardly relative to the upper wing skin of respective wings **14**A, **14**B. In some embodiments, fence skins **46** may also extend in the respective lateral directions of wings **14**A, **14**B (i.e., laterally away from longitudinal axis LA, in respective outboard directions) and may define a cradle or “V” shape for receiving part of fuselage portion **18**A therein during assembly as explained below.
(34) FIG. **4** also illustrates the curvature of upper wing skin portion **34** defined by wings **14**. Upper wing skin portion **34** may have a convex curvature relative to wing unit **12**. For example part(s) of upper wing skin portion **34** may have a rounded shape that extends outwardly (i.e., generally upwardly) relative to wing unit **12**. For example, in some embodiments, at least some of upper wing skin portion **34** may be non-parallel to longitudinal axis LA of fuselage portion **18**A.
(35) In embodiments where upper wing skin portion **34** defines part (e.g., a pressure floor) of the pressure vessel defined by fuselage portion **18**A, the convex curvature of upper wing skin portion **34** may provide structural advantages including increased stiffness relative to a flat floor of otherwise comparable construction. Accordingly, the (e.g., convex) curvature of upper wing skin portion **34** may result in less structural reinforcement being required compared to a flat floor and

hence may result in reduced weight in some embodiments. Also, the use of upper wing skin portion **34** as the pressure floor may, in some embodiments, eliminate the need for fuselage portion **18**A to have a separate pressure floor disposed above wing skin portion **34**.

(36) FIG. **5**A is a partial perspective view of wing unit **12** where part of a forward spar of wing unit **12** has been omitted to show the interior of part of wing unit **12**. Wing unit **12** may comprise root rib **50**, which may be disposed at or near a root of wing **14**A. Wing **14**B may have a substantially identical construction as wing **14**A and the description of wing **14**A herein may also apply to wing **14**B. Root rib **50** may be disposed under or near pressure fence **28**A so that pressure fence **28**A may be attached to root rib **50** and that root rib **50** may provide some structural support for pressure fence **28**A. Upper wing skin portion **34** may be supported by root rib **50** and therefore root rib **50** may at least partially define the curvature of upper wing skin portion **34**. Similarly, upper wing skin portion **34** may be supported by a root rib (not shown) of wing **14**B and therefore such root rib may also at least partially define the curvature of upper wing skin portion **34**. In some embodiments, upper wing skin portion **34** may have a construction that is substantially symmetric relative to longitudinal axis LA. In some embodiments, upper wing skin portion **34** may have a construction that is substantially symmetric relative to a plane in which upper seam **32** and middle rib **40** lie.

(37) Upper wing skin portion **34** may also be supported by middle rib **40** of wing unit **12** and therefore middle rib **40** may at least partially define the curvature of upper wing skin portion **34**. In some embodiments, an upper portion of root rib **50** and an upper portion of middle rib **40** may define different curvatures so that upper wing skin portion **34** may have a varying curvature across its span. Alternatively, the upper portion of root rib **50** and the upper portion of middle rib **40** may have parts thereof that are of substantially identical curvatures so that upper wing skin portion **34** may have a constant curvature across its span between middle rib **40** and root rib **50**. Even though upper wing skin portion **34** may not be exposed to airflow during flight, it may nevertheless have the same aerodynamic profile as wing **14**A (e.g., and as wing **14**B) at the root of wing **14**A as defined by root rib **50**.

(38) FIG. **5**B is an enlarged perspective cross-sectional view of upper seam **32** in upper wing skin portion **34** of wing unit **12**. FIG. **5**C is an enlarged perspective cross-sectional view of lower seam **36** in lower wing skin **38** of wing unit **12**. Upper seam **32** and lower seam **36** may define a structural interface between first and second portions **12**A, **12**B of wing unit **12** and may permit portions **12**A, **12**B to be manufactured as subunits and subsequently assembled together to form wing unit **12**.

(39) In reference to FIG. 5B, upper seam **32** may comprise a splice joint between two panels of upper wing skin portion **34** where upper external strap **52** may overlap both panels of upper wing skin portion **34** and may be secured to both panels by way of suitable fasteners **54** extending through upper external strap **52**, through upper wing skin portion **34** and through flanges of middle rib **40**. In other words, upper external strap **52** may serve as a splice joining adjacent panels of upper wing skin portion **34** together and to middle rib **40**. In some embodiments, where upper wing skin portion **34** also serves as a pressure floor, upper seam **32** may be suitably sealed to withstand the pressurization load of the passenger cabin of fuselage portion **18**A. For example, one or more surfaces within upper seam **32** may comprise suitable fay surface sealant to achieve suitable sealing.

(40) In reference to FIG. 5C, lower seam **36** may comprise a splice joint between two panels of lower wing skin **38** where lower external strap **56** and lower internal strap **58** may overlap both panels of lower wing skin **38** and may be secured to both panels by way of suitable fasteners **54** extending through lower external strap **56**, through lower internal strap **58**, through lower wing skin **38** and through flanges of middle rib **40**. In other words, lower external strap **56** and lower internal strap **58** may serve as splices joining adjacent panels of lower wing skin **38** together and to middle rib **40**.

(41) Wing unit **12** may be constructed using conventional or other fasteners and other materials

suitable for aircraft structures. For example, in various embodiments, wing unit **12** may comprise suitable metallic and/or composite materials. In some embodiments, upper wing skin portion **34**, upper external strap **52** and/or other components of wing unit **12** may comprise a suitable aluminum-lithium alloy for example. In some embodiments, upper wing skin portion **34**, upper external strap **52** and/or other components of wing unit **12** may comprise a suitable carbon fiber reinforced polymer for example.

(42) FIG. **6** is a flowchart illustrating a method **1000** for producing wing unit **12** for assembly with fuselage portion **18**A of aircraft **10**. In various embodiments, method **1000** may comprise assembling first portion **12**A of wing unit **12** (see block **1002**), assembling second portion **12**B of wing unit **12** (see block **1004**), and then finishing an interface (e.g., seams **32** and **36**) for assembling first portion **12**A with second portion **12**B prior to assembling wing unit **12** with fuselage portion **18**A of aircraft **10** (see block **1006**). As explained above, first portion **12**A may comprise wing **14**A configured to extend in the first lateral direction relative to fuselage portion **18**A, and pressure fence **28**A configured to define a first part of the pressure vessel partially defined by fuselage portion **18**A. Similarly, second portion **12**B may comprise wing **14**B configured to extend in the second lateral direction relative to fuselage portion **18**A, and pressure fence **28**B configured to define a second part of the pressure vessel partially defined by fuselage portion **18**A.

(43) Method **1000** and the configuration of wing unit **12** may permit first and second portions **12**A, **12**B to be manufactured at a first facility (e.g., supplier) and then shipped as separate sub-units to a second facility (e.g., aircraft manufacturer). The two portions **12**A, **12**B of wing unit **12** may then be assembled at the second facility to form wing unit **12**. In some embodiments, the interface (e.g., seams **32** and **36**) may be at least partially finished at the first facility prior to shipping so that first and second portions **12**A, **12**B may be readily assembled together upon arrival at the second facility. The finishing of the interface may comprise drilling, reaming and/or deburring holes in upper wing skin portion **34**, upper external strap **52**, middle rib **40**, lower wing skin **38**, lower external strap **56** and lower internal strap **58** for fasteners **54** to be installed at seams **32**, **36** while wings **14** of first and second portions **12**A, **12**B are positioned in their respective in-use configurations (e.g., with proper dihedral angle, pitch, roll) relative to each other. Accordingly, the advanced preparation (e.g., pre-drilling of holes) of the interface at the first facility may facilitate the assembly of first and second portions **12**A, **12**B at their proper positions (including orientations) relative to each other at the second facility. Finishing of the interface is intended to encompass tasks associated with making the interface ready for attachment and may include pre-forming corresponding holes in both portions **12**A, **12**B of wing unit **12** so that subsequent assembly of the two portions **12**A, **12**B will result in the two portions **12**A, **12**B being correctly positioned relative to each other. In other words, finishing the interface comprises incorporating in-use relative positional constraints of the two portions **12**A, **12**B of wing unit **12** into the interface.

(44) Similarly, pressure fences **28**A and **28**B may be pre-assembled with their respective wings **14**A, **14**B of wing unit **12** at the first facility to be in their respective in-use positions (including orientations) relative to wing unit **12**. This may be achieved in any suitable way. In some embodiments, method **1000** may include positioning wings **14** in their respective in-use configurations relative to each other and then assembling pressure fence **28**A with wing **14**A and assembling pressure fence **28**B with wing **14**B so that pressure fences **28**A and **28**B may be ready to interface with fuselage portion **18**A when wing unit **12** is assembled with fuselage portion **18**A.

(45) FIGS. **7**A and **7**B graphically illustrate a method for producing an aircraft structural assembly using fuselage portion **18**A partially defining a pressure vessel and pre-assembled wing unit **12** as described herein. FIGS. **7**A and **7**B show parts of fuselage portion **18**A and of wing unit **12** when viewed along longitudinal axis LA from an aft position relative to wing unit **12** and toward a forward direction relative to aircraft **10**. In various embodiments, the method may comprise assembling wing unit **12** with fuselage portion **18**A so that pressure fence **28**A defines a first part of

the pressure vessel partially defined by fuselage portion **18**A and second pressure fence **28**B defines a second part of the pressure vessel partially defined by fuselage portion **18**A. Respective upper portions of pressure fences **28**A, **28**B may be configured to interface with one or more structural members of fuselage portion **18**A.

(46) Fuselage portion **18**A may comprise cabin floor **60**, which is only partially shown in FIGS. **7**A and **7**B. Cabin floor **60** may partially define passenger cabin **62** disposed within the pressure vessel cooperatively defined by fuselage portion **18**A and wing unit **12**. For example, the pressure vessel may be partially defined by fuselage skin **64**, fence skins **46**, upper wing skin portion **34** and other components. FIG. **7**A shows wing unit **12** being brought toward fuselage portion **18**A along arrows A and FIG. **7**B shows wing unit **12** being in its final (i.e., in-use) assembled position relative to fuselage portion **18**A. Fuselage portion **18**A may comprise fuselage frames **66** supporting and generally defining the shape of fuselage skin **64**. Fuselage portion **18**A may also comprise stringers **68**, sometimes called longerons, attached to fuselage frames **66** and extending generally along longitudinal axis LA. Stringers **68** may also support fuselage skin **64**.

(47) The use of pressure fences **28**A, **28**B as disclosed herein may facilitate the assembly of wing unit **12** to fuselage portion **18**A. For example, joining interfaces between wing unit **12** and fuselage portion **18**A may include joints between fence frames **48** and respective fuselage frames **66** and also joints between fence skins **46** and respective stringers **68** as explained below. Such joining interfaces may be disposed vertically above cabin floor **60** and facilitate access to such joining interfaces by assembly personnel. For example, an upper portion of each fence skin **46** may be attached to a respective corresponding stringer **68** of fuselage portion **18**A.

(48) The shape and configuration of pressure fences **28**A, **28**B may further facilitate assembly whereby pressure fences **28**A and **28**B may cooperatively define a cradle or receptacle comprising a “V” shape into which part of fuselage portion **18**A such as fuselage frames **66** may be received when wing unit **12** is raised toward fuselage portion **18**A and approaches its final assembled position relative to fuselage portion **18**A. For example, each fence skin **46** may extend upwardly relative to upper wing skin portion **34** and also in a respective lateral direction (i.e., away from each other). The shape cooperatively defined by pressure fences **28**A and **28**B may, in some embodiments, facilitate assembly by providing some self-alignment function as wing unit **12** and fuselage portion **18**A are brought together. Fence skins **46** may each overlap one or more fuselage frames **66**. In some embodiments, fence skins **46** may be attached to fuselage frames **66**.

(49) FIG. **8** is an axial cross-sectional view through fuselage portion **18**A and wing unit **12** showing fuselage portion **18**A and wing unit **12** in their respective assembled in-use positions. The assembly of wing unit **12** with fuselage portion **18**A may be achieved by bringing wing unit **12** and fuselage portion **18**A together using fuselage supports **24** and/or wing supports **26** (see FIG. **2**) and then attaching wing unit **12** and fuselage portion **18**A together at a plurality of joining locations. During an early stage of the assembly process, wing unit **12** and fuselage portion **18**A may define a first structural interface intended to provide one or more initial points of attachment and a second structural interface intended to provide one or more subsequent points of attachment between wing unit **12** and fuselage portion **18**A. The first structural interface may be configured so that when fuselage portion **18**A and wing unit **12** are attached together at the first structural interface but are unattached at the second structural interface, the first structural interface permits relative positional adjustment between wing unit **12** and fuselage portion **18**A.

(50) In some embodiments, the second structural interface may initially be unfinished (i.e., does not incorporate final in-use relative positional constraints of wing unit **12** and fuselage portion **18**A) so that it may be finished only after such relative positional adjustment between fuselage portion **18**A and wing unit **12**. The first structural interface may accordingly provide an initial point of attachment between fuselage portion **18**A and wing unit **12** and also accommodate some relative positional adjustment between fuselage portion **18**A and wing unit **12** in one or more degrees of freedom within respective predetermined tolerances. The relative positional adjustment between

fuselage portion **18**A and wing unit **12** may be achieved by way of fuselage supports **24** and/or wing supports **26** (see FIG. **2**), which may be actuated. The positional adjustment afforded by the first structural interface may permit the second interface to be finished only after the desired positional adjustment has been done and while wing unit **12** and fuselage portion **18**A are attached via the first interface and are supported by wing supports **26** and fuselage supports **24** respectively. The finishing of the second interface may, for example, comprise drilling, reaming and/or deburring holes to receive suitable fasteners.

(51) Finishing the second interface in situ while wing unit **12** and fuselage portion **18**A are in their final positions relative to each other may facilitate the assembly process. For example, instead of trying to align pre-drilled holes on parts of wing unit **12** with pre-drilled holes on parts of fuselage portion **18**A at different joining locations and facing challenges associated with tolerance stack-up, the finishing of the holes in situ facilitates the alignment of the corresponding holes. In some embodiments, one or more first holes in one of wing unit **12** or fuselage portion **18**A may be pre-drilled while corresponding one or more second holes in the other of wing unit **12** or fuselage portion **18**A may be drilled and/or reamed after positional adjustment while using the first holes as respective guides to ensure suitable alignment of the first holes and second holes. In some embodiments, one or more first holes in wing unit **12** may be absent or otherwise unfinished (e.g., pilot holes only) and one or more corresponding second holes in fuselage portion **18**A may also be absent or otherwise unfinished so that the first holes and the second holes may be drilled and/or reamed (e.g., together, simultaneously) after positional adjustment to ensure suitable alignment.

(52) The first structural interface and the second structural interface may each comprise one joint or a plurality of joints at different locations. In some embodiments, the first interface providing the initial point(s) of attachment may, for example, comprise one or more aft tension fittings **74** for attachment with aft pressure wall **88** of fuselage portion **18**A. Aft tension fitting(s) **74** may be disposed at or proximal to an aft portion of wing unit **12**. For example, aft tension fittings **74** may be attached to or integrated into an aft spar of wing unit **12**. In some embodiments, the second interface providing the subsequent point(s) of attachment may, for example, comprise: aft keel beam fitting **44** of wing unit **12** for attachment with aft keel beam **76** of fuselage portion **18**A; forward keel beam fitting **42** of wing unit **12** for attachment with forward keel beam **78** of fuselage portion **18**A; one or more forward tension fittings **80** of wing unit **12** for attachment with one or more respective floor beams **82** supporting cabin floor **60** of fuselage portion **18**A; upper portions of fence skins **46** of wing unit **12** for attachment with respective stringers **68** of fuselage portion **18**A and fence frames **48** of wing unit **12** for attachment with respective fuselage frames **66**.

(53) In some embodiments, some or all of the joining locations between wing unit **12** and fuselage portion **18**A may be disposed outside of wing unit **12** so that the need for assembly personnel to physically access the interior of wing unit **12** during structural assembly of wing unit **12** with fuselage assembly **18**A may be reduced or eliminated. Additionally, some of the joining locations between pressure fences **28**A, **28**B may be disposed above cabin floor **60** of fuselage portion **18**A to further facilitate access to such joining locations. The joining locations disclosed herein may facilitate the structural assembly process and also promote a shorter assembly time.

(54) In various embodiments, the first interface may accommodate positional adjustment to achieve pitch adjustment of wing unit **12** relative to fuselage portion **18**A. For example, aft tension fitting(s) **74**, located at an aft portion of wing unit **12** may permit vertical adjustment of a forward portion of wing unit **12** along arrow P within a predetermined tolerance for the purpose of achieving pitch adjustment. Such pitch adjustment may be achieved by causing some rotation or pivoting movement of wing unit **12** about tension fitting(s) **74** for example. In some embodiments, the first interface may be configured to additionally or instead accommodate positional yaw and/or roll adjustment of wing unit **12** relative to fuselage portion **18**A while wing unit **12** and fuselage portion **18**A are unattached at the second interface.

(55) In some embodiments one or more struts **84** may extend between floor beams(s) **82** and upper

wing skin portion **34**. Struts **84** may define respective load paths between upper wing skin portion **34** and the structure of fuselage portion **18**A. Struts **84** may provide structural support for upper wing skin portion **34**. In some embodiments, struts **84** may be distributed across the area of upper wing skin portion **34**. In reference to the curvature of upper wing skin portion **34**, at least some of upper wing skin portion **34** may be non-parallel to floor beam(s) **82**.

(56) FIG. **9** is perspective view of an axial cross-section through fuselage portion **18**A and wing unit **12**. The pressure vessel defined around passenger cabin **62** in fuselage portion **18**A may be partially defined by fuselage skin **64**, forward pressure wall **86**, forward pressure floor **87**, upper wing skin portion **34** of wing unit **12**, fence skins **46**, aft pressure wall **88** and aft pressure floor **90**. Upper wing skin portion **34** may serve as a pressure floor to such pressure vessel instead of requiring a separate pressure floor to be disposed above upper wing skin portion **34**. Joining locations between upper wing skin portion **34** and forward pressure wall **86** and between upper wing skin portion **34** and aft pressure wall **88** may comprise fay surface sealant to achieve suitable sealing for withstanding pressurization of passenger cabin **62**. The region that is shown forward of forward pressure wall **86** may be a cargo compartment of aircraft **10**.

(57) FIG. **10** is perspective view of an aft portion of wing unit **12** assembled with fuselage portion **18**A. In some embodiments, wing unit **12** may comprise two aft tension fittings **74** serving as the first interface to provide initial attachment of wing unit **12** to fuselage portion **18**A. Aft tension fittings **74** may each be part of a bolted joint for attaching an aft portion of wing unit **12** to aft pressure wall **88** of fuselage portion **18**A using bolts **92**. In some embodiments, aft tension fittings **74** may be disposed on opposite lateral sides of longitudinal axis LA of the fuselage portion **18**A. In some embodiments, aft tension fittings **74** may be disposed at equal lateral distances from longitudinal axis LA.

(58) In some embodiments, both aft tension fittings **74** may be disposed at a substantially common longitudinal position relative to longitudinal axis LA. The longitudinal alignment of both aft tension fittings **74** may effectively define a hinge line about which pitch adjustment of wing unit **12** may be made within predetermined tolerances when wing unit **12** and fuselage portion **18**A are attached at aft tension fittings **74** but are unattached at the other joining locations of the second structural interface.

(59) Aft keel beam fitting **44** may be part of the second interface which is finished after relative positional adjustment between wing unit **12** and fuselage portion **18**A. A suitable fastener such as a bolt or pin may be used to attach aft keel beam fitting **44** to aft keel beam **76**. In some embodiments, one or more holes for receiving the fastener may be pre-finished in aft keel beam fitting **44** and may be used as a guide for finishing (e.g., drilling, reaming) corresponding one or more holes in aft keel beam **76** after the relative positional adjustment between wing unit **12** and fuselage portion **18**A to ensure acceptable alignment. Alternatively, one or more holes for receiving the fastener may be pre-finished in aft keel beam fitting **46** and may be used as a guide for finishing (e.g., drilling, reaming) corresponding one or more holes in aft keel beam fitting **44** after the relative positional adjustment between wing unit **12** and fuselage portion **18**A to ensure acceptable alignment.

(60) Forward keel beam fitting **42** (shown in FIG. **9**) may also be part of the second interface and may be configured similarly to aft keel beam fitting **44**. Accordingly, forward keel beam fitting **42** may be attached to forward keel beam **78** in the same or in a similar manner as aft keel beam fitting **44** is attached to aft keel beam **76**.

(61) FIG. **11**A shows a bolted joint between wing unit **12** and fuselage portion **18**A comprising aft tension fitting **74**, in a configuration permitting relative positional adjustment between wing unit **12** and fuselage portion **18**A. FIG. **11**B shows the bolted joint of FIG. **11**A in a fully assembled configuration. In the fully assembled configuration of FIG. **11**B where wing unit **12** and fuselage portion **18**A are completely assembled together in their in-use configuration, each bolted joint may comprise one or more (e.g., three) bolts **92** that are torqued to their respective final torque values.

However, in the adjustment configuration shown in FIG. **11**A, the one or more bolts **92** may be torqued to respective values that are lower than their respective final torque values. In some embodiments, such lower torque values may be about 10% of the respective final torque values.
(62) In some embodiments, the adjustment configuration of FIG. **11**A may include fewer bolts **92** than the final configuration of FIG. **11**B. For example, in the adjustment configuration, each aft tension fitting **74** may be fitted with only one (e.g., slave) bolt **92** to provide an initial point of attachment. In some embodiment, the hole formed in aft tension fitting **74** or in aft pressure wall **88** for receiving bolt **92** may be made slightly oversize relative to bolt **92** so as to provide an allowance for relative positional adjustment (e.g., pitch and yaw) between wing unit **12** and fuselage portion **18**A. In this configuration, the holes for the other bolts **92** used in the final configuration may be absent or otherwise unfinished and may be finished at the suitable locations and orientations only after the positional adjustment.
(63) The use of aft tension fittings **74** in the adjustment configuration of FIG. **11**A may facilitate the relative positional adjustment between wing unit **12** and fuselage assembly **18**A using wing supports **26** and fuselage supports **24** (shown in FIG. **2**) by providing an initial attachment point between wing unit **12** and fuselage assembly **18**A that anchors the two assemblies together yet that also accommodates relative positional adjustment.
(64) In order to facilitate pitch adjustment, an interfacing contact area in the bolted joints at aft tension fitting **74** may be relatively small relative to a chord length of wing unit **12** where the chord refers to an imaginary straight line joining the leading and trailing edges of wing **14**A and/or wing **14**B. For example, in some embodiments, a width W of such contact area may be about 1% of a maximum chord length of wing unit **12**. In some embodiments, the width W of the contact area may be less than about 1% of the maximum chord length of wing unit **12**. In some embodiments, the width W of the contact area may be less than about 3% of the maximum chord length of wing unit **12**. In some embodiments, the width W of the contact area may be between about 1% and about 3% of the maximum chord length of wing unit **12**. In some embodiments, the width W of the contact area may be less than 5% of the maximum chord length of wing unit **12**. In some embodiments, the width W of the contact area may be between about 1% and about 5% of the maximum chord length of wing unit **12**.
(65) Roll positional adjustment of wing unit **12** relative to fuselage portion **18**A may comprise shimming interfacing contact areas of the one or more bolted joints comprising aft tension fittings **74**. For example, the laterally-opposed positions of the two aft tension fittings **74** relative to longitudinal axis LA may facilitate such roll positional adjustment.
(66) FIG. **12**A is a perspective view of exemplary splice joints between fence frames **48** of wing unit **12** and fuselage frames **66** of fuselage portion **18**A. These joints may each comprise frame splice **94** overlapping both fence frames **48** and fuselage frames **66** and may be secured to fence frames **48** and fuselage frames **66** by way of suitable fasteners **96**. These splice joints may be part of the second interface which is finished after relative positional adjustment between wing unit **12** and fuselage portion **18**A. In some embodiments, one or more holes for receiving fasteners **96** may initially be unfinished and may only be finished (e.g., drilled) after the relative positional adjustment between wing unit **12** and fuselage portion **18**A to ensure suitable alignment.
(67) FIG. **12**B is a perspective cross-sectional view taken along line **12-12** of FIG. **12**A extending through splice **94** and fuselage frame **66**.
(68) FIG. **13** is a perspective cross-sectional view through an exemplary joint between fence skin **46** of wing unit **12** and stringer **68** of fuselage portion **18**A. The cross-section of FIG. **13** is taken transversely to stringer **68**. An upper portion of fence skin **46** may be attached to stringer **68**, which may be disposed above cabin floor **60** (see FIGS. **7**A and **7**B). This joint may also comprise a splice joint between fuselage skin **64** and fence skin **46** where skin splice **98** may overlap both fuselage skin **64** and fence skin **46** and may be secured to both fuselage skin **64** and fence skin **46** by way of suitable fasteners **100** extending through stringer **68**, through skin splice **98** and through fuselage

skin **64** or fence skin **46**. This joint may also be part of the second interface which is finished after relative positional adjustment between wing unit **12** and fuselage portion **18**A. In some embodiments, one or more holes for receiving fasteners **100** may initially be unfinished and may only be finished (e.g., drilled) after the relative positional adjustment between wing unit **12** and fuselage portion **18**A to ensure suitable alignment.
(69) FIG. **14** is a perspective view showing an exemplary forward tension fitting **80** of wing unit **12** for attaching a forward portion of wing unit **12** to floor beam **82**. It is understood that wing unit **12** may comprise a plurality of such forward tension fittings **82** for attachment to a plurality of respective floor beams **82** using fastener **102**. In some embodiments, forward pressure floor **87** may be disposed between forward tension fitting **80** and floor beam **82** and fastener **102** may also extend through forward pressure floor **104**. In some embodiments, suitable shims **104** may also be disposed between forward tension fitting **80** and floor beam **82**.
(70) This joint may also be part of the second interface which is finished after relative positional adjustment between wing unit **12** and fuselage portion **18**A. In some embodiments, one or more holes for receiving fasteners **102** may initially be unfinished and may only be finished (e.g., drilled) after the relative positional adjustment between wing unit **12** and fuselage portion **18**A to ensure suitable alignment. This joint may comprise fay surface sealant to achieve suitable sealing for withstanding pressurization of passenger cabin **62**.
(71) FIG. **15** is a perspective view of upper wing skin portion **34** of wing unit **12** in relation to floor beams **82** of fuselage portion **18**A. Struts **84** may be installed after the relative positional adjustment between wing unit **12** and fuselage portion **18**A. Struts **84** may define respective load paths between upper wing skin portion **34** and floor beams **82**. Struts **84** may be distributed across the area of upper wing skin portion **34**. Struts **84** may comprise turnbuckles or otherwise permit lengthwise adjustment of struts **84** to facilitate installation.
(72) FIG. **16** is a perspective view of an exterior of the pressure fence **28**A when wing unit **12** and fuselage portion **18**A are assembled together. In some embodiments one or more additional skin splices such as cruciform doubler **106** may be used to attach fence skin **46** to fuselage skin **64**. When aircraft **10** is fully assembled and ready for service, the region of the root of wing **14**A including fence skin **46** may be covered by suitable aerodynamic fairing(s) so that such additional skin splices applied to the exterior of fence skin **46** may not affect aerodynamic performance.
(73) FIG. **17** is a flowchart illustrating an exemplary method **2000** for assembling wing unit **12** with fuselage portion **18**A. It is understood that the execution of method **2000** is not limited to the specific exemplary construction of wing unit **12** and fuselage portion **18**A disclosed herein. In various embodiments, method **2000** may comprise: attaching fuselage portion **18**A and wing unit **12** together at a first structural interface (e.g., aft tension fittings **74**) between fuselage portion **18**A and wing unit **12** (see block **2002**), the first structural interface being configured to permit relative positional adjustment between wing unit **12** and fuselage portion **18**A; while fuselage portion **18**A and wing unit **12** are attached at the first structural interface and while fuselage portion **18**A and wing unit **12** are unattached at an unfinished second structural interface, performing relative positional adjustment between wing unit **12** and fuselage portion **18**A (see block **2004**); after the relative positional adjustment between wing unit **12** and fuselage portion **18**A, finishing the second structural interface between fuselage portion **18**A and the wing unit **12** (see block **2006**) while wing unit **12** and fuselage portion **18**A are in their adjusted configuration; and attaching the fuselage portion and the wing unit at the second structural interface after finishing the second structural interface (see block **2008**).
(74) In some embodiments, wing unit **12** may be temporarily moved away from fuselage portion **18**A (or fuselage portion **18**A may be temporarily moved away from wing unit **12**) after finishing of the second structural interface and before attaching fuselage portion **18**A and wing unit **12** at the second structural interface (i.e., between blocks **2006** and **2008**). This temporary movement may require detachment of first structural interface (e.g., aft tension fittings **74**) so that wing unit **12**

may be moved far enough away from fuselage portion **18**A to permit deburring of newly drilled holes and also the application of fay surface sealant to some of the joining surfaces for example. Wing unit **12** and fuselage portion **18**A may then be brought back together to be attached at both the first interface and at the second interface in their fully-assembled configuration.
(75) In various embodiments, the relative positional adjustment may comprise a pitch adjustment, a yaw adjustment and/or a roll adjustment of wing unit **12** relative to fuselage portion **18**A.
(76) In some embodiments, attaching fuselage portion **18**A and wing unit **12** at the first structural interface may comprise torqueing a bolted joint of the first structural interface to a value that is less than (e.g., 10% of) a final torque value of the bolted joint. The relative positional adjustment may comprise rotating wing unit **12** about the first structural interface.
(77) The above description is meant to be exemplary only, and one skilled in the relevant arts will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. The present disclosure may be embodied in other specific forms without departing from the subject matter of the claims. The present disclosure is intended to cover and embrace all suitable changes in technology. Modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims. Also, the scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

Claims

1. A method for producing an aircraft structural assembly using a fuselage portion partially defining a pressure vessel and an assembled wing unit wherein the assembled wing unit comprises: a first wing extending in a first lateral direction relative to the fuselage portion and a second wing extending in an opposite second lateral direction relative to the fuselage portion; a first pressure fence attached to the first wing; and a second pressure fence attached to the second wing, the method comprising: assembling the assembled wing unit with the fuselage portion so that the first pressure fence defines a first part of the pressure vessel partially defined by the fuselage portion and the second pressure fence defines a second part of the pressure vessel partially defined by the fuselage portion, wherein: the fuselage portion comprises a fuselage skin supported by a fuselage frame; the first pressure fence comprises a first fence skin and the second pressure fence comprises a second fence skin; the second fence skin extends upwardly relative to an upper wing skin of the second wing and also in the second lateral direction the assembling the assembled wing unit with the fuselage portion includes: abutting a first surface of an upper portion of the first fence skin with a portion of a surface of the fuselage skin forming a first contact area; abutting a portion of a second surface of the upper portion of the first fence skin with a portion of a surface of the fuselage frame of the fuselage portion forming a second contact area, the second contact area being at an angle from the first contact area; and using the upper portion of the first fence skin extending upwardly to guide the fuselage frame for self-alignment in the first or second lateral direction between the fuselage portion and the first pressure fence.
2. The method as defined in claim 1, comprising receiving part of the fuselage portion into a cradle cooperatively defined by the first pressure fence and the second pressure fence of the assembled wing unit.
3. The method as defined in claim 1, comprising: attaching the first pressure fence to the fuselage portion at a first joining location that is disposed vertically above a cabin floor of the fuselage portion; and attaching the second pressure fence to the fuselage portion at a second joining location that is disposed vertically above the cabin floor of the fuselage portion.
4. The method as defined in claim 1, comprising: attaching the first fence skin of the first pressure fence to a first stringer of the fuselage portion, the first stringer being disposed vertically above a

cabin floor of the fuselage portion; and attaching the second fence skin of the second pressure fence to a second stringer of the fuselage portion, the second stringer being disposed vertically above the cabin floor of the fuselage portion.

5. The method as defined in claim 4, comprising: the fuselage frame is a first fuselage frame; the method further comprises: attaching a first fence frame of the first pressure fence to the first fuselage frame at a first joining location disposed vertically above the cabin floor of the fuselage portion; and attaching a second fence frame of the second pressure fence to a second fuselage frame of the fuselage portion at a second joining location disposed vertically above the cabin floor of the fuselage portion.