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Aircraft component support arrangement, high-lift system, aircraft wing and aircraft

Abstract

An aircraft component support arrangement for connecting an aircraft component to an aircraft wing is disclosed including a component support and an attachment device for attaching the component support to a wing structure. The attachment device includes first to third connection means for connecting the component support to the wing structure, the first to third connection means each including a floating bearing permitting linear movement in direction of a first to third axis, respectively, and angular rotation about a central point in two orthogonal directions. The first to third connection means are spaced apart from each other in two dimensions to connect the component support at three different locations to the wing structure. At least one of the first to third axes has a different orientation to the others of the first to third axes.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION
(1) This application claims priority to European Patent Application Number EP 23159111.6, filed Feb. 28, 2023, the entire contents of which is hereby incorporated by reference.
BACKGROUND
(2) The present disclosure relates to an aircraft component support arrangement for connecting an aircraft component to an aircraft wing, including a component support and an attachment device for attaching the component support to a wing structure. Furthermore, the disclosure relates to a high-lift system, an aircraft wing and an aircraft having such an aircraft component support arrangement.

(3) More specifically, the present disclosure relates to solutions for mounting a fixed structure for supporting an aircraft component to a wing. For example, the aircraft component may be flap track or any other moving mechanism for moving a control surface element such as a flap, a slat or the like, but the aircraft component could also be an engine or any other aircraft part that is carried by the wing. Hence, the component support could be an engine pylon or any other supporting structure that is carried by the wing.
(4) For background information, reference is made to WO 2009/019 011A2 disclosing a control surface support arrangement for movably supporting a control surface element, especially a flap of a high-lift system, of an aircraft, including a control surface support and an attachment device for attaching the control surface support to an aircraft structure, especially an aircraft wing structure.
SUMMARY
(5) The present invention encompasses enhancing an attachment device for attaching a component support to an aircraft wing such that it has a simple and compact design and has a better performance in handling local deformations.
(6) The invention also contemplates having an aircraft component support arrangement for connecting an aircraft component to an aircraft wing, including a component support and an attachment device for attaching the component support to a wing structure of the aircraft wing, the attachment device comprising: a first connection means for connecting the component support to the wing structure, the first connection means comprising a first floating bearing permitting linear movement in direction of a first axis and angular rotation about a central point in two orthogonal directions, a second connection means for connecting the component support to the wing structure, the second connection means comprising a second floating bearing permitting linear movement in direction of a second axis and angular rotation about a central point in two orthogonal directions, a third connection means for connecting the component support to the wing structure, the third connection means comprising a third floating bearing permitting linear movement in direction of a third axis and angular rotation about a central point in two orthogonal directions, wherein the first to third connection means are spaced apart from each other in two dimensions to connect the component support at three different locations to the wing structure and wherein at least one of the first to third axes has a different orientation to the others of the first to third axes.
(7) According to an exemplary embodiment, the first and second axes may be oriented parallel to each other and are spaced apart from each other wherein the third axis has at least one direction component perpendicular to the first and second axes.
(8) The first to third floating bearings may comprise spherical bearings or spherical plain bearings.
(9) Each of the first to third connection means may comprise a bolt to be connected to one of component support and the wing structure wherein the spherical bearing is movable in direction of the bolt axis and has a lug connected to the other of the component support and the wing structure.
(10) The first connection means may be part of a front attachment of the component support, and the second and third connection may be parts of a rear attachment of the component support.
(11) The component support may be chosen from the group consisting of a control surface support for movably supporting a control surface, a high-lift control surface element for movably supporting a control surface element of a high-lift system, a flap support for movably supporting a flap moving mechanism of a flap, and an engine pylon.
(12) The first and second axes may be directed in the flight direction and are spaced apart from each other in spanwise direction. The third axis may be directed in a horizontal direction and/or has at least a direction component extending in the spanwise direction.
(13) The attachment device may comprise only floating bearings and no fixed bearing.
(14) According to an exemplary embodiment, the invention also may contemplate providing a high-lift system for an aircraft, comprising a high-lift control surface element and an aircraft component support arrangement according to any of the aforementioned embodiments for movably supporting the high-lift control surface element.

(15) The high-lift system may be configured as a flap device wherein the high-lift control surface element is a flap and the aircraft component support arrangement is configured to movably supporting the flap on a trailing edge region of the aircraft wing.
(16) According to an exemplary embodiment, an aircraft wing is disclosed comprising an aircraft wing structure, especially a wing box, and an aircraft component support arrangement according to any of the aforementioned embodiments for connecting an aircraft component to the wing.
(17) The aircraft component may be a high-lift control surface element, especially a flap. The aircraft component support arrangement may support a flap moving mechanism for moving the flap and is attached to the wing structure by means of the attachment device.
(18) According to an exemplary embodiment, an aircraft is disclosed comprising an aircraft component support arrangement, a high-lift system and/or an aircraft wing according to any of the aforementioned embodiments.
(19) The present disclosure may provide an improved design for mounting a fixed structure to a wing. According to an exemplary embodiment, the fixed structure is a control surface support such as a support for a flap track or any other control surface element moving mechanism, but it could equally be an engine pylon or another aircraft structure to be carried on the wing.
(20) According to an exemplary embodiment, an aircraft wing attachment concept is disclosed for holding aircraft components to be carried on the wing. Some exemplary embodiments are related to a wing for holding high-lift devices like flaps.
(21) According to an exemplary embodiment, a flap support attachment concept is disclosed.
(22) According to an exemplary embodiment, the flaps are mounted on flap support structures, which are transferring the flaps-loads to the wing structure such as a wing box and which are also part of the high-lift mechanisms for deploying the flaps. Examples for the component support are flap support beams or flap supports.
(23) Most of the flap loads are transferred by the support beams/ribs into the wing box. According to an exemplary embodiment, the highly loaded structural connection between the wing box and the support beams is designed with a front attachment and a rear attachment. Some exemplary embodiments are mainly related to the mechanical connection of the front attachment and the rear attachment.
(24) According to an exemplary embodiment, the attachment device is designed as dual load path connection (DLP) with a main load path that normally carries all the load and a secondary load path acting as a failsafe attachment. Some exemplary embodiments of the invention relate to improvements of the main load path, and elements of the secondary load path will not be described in detail.
(25) Some exemplary embodiments of the invention are directed to an isostatic three floating lug attachment concept.
(26) According to an exemplary embodiment, an attachment concept for a component support consists of three floating lugs in different orientation. Each lug is equipped with a floating bearing (slave function) in direction of an axis of a bolt. The simple and compact design can be easily integrated into the wing structure and can also be easily designed as dual load path (DLP) design. A rigging of the component support can be performed with shims/sleeves and eccentric bushes. The complete attachment system is isostatic, so all loads are fully determined.
(27) The component support is a support structure configured to support any aircraft component that shall be connected to an aircraft wing. The component support may be attached via this attachment concept to a wing structure such as a wing box.
(28) An attachment concept of exemplary embodiments may use three connecting means with floating bearings has one or several or all of the following benefits: 1) compact design, helps reducing the structural weight and size of fairings; 2) additional space behind a rear spar (no spigot bracket or similar), more space for system installation purposes; 3) easy integration into the wing box; 4) isostatic design of the attachment concept (no constraint loads under deformation); 5) dual

load path design can be easily integrated, with a lug to lug design and a dual load path bolt connection; and, 6) with eccentric bushes or bolts and shim plated the rigging of the component support, especially of support beams/ribs, can be performed.
(29) According to exemplary embodiments, the isostatic floating lug concept comprises three spherical bearings or consists of three spherical bearings. Each spherical bearing has a lateral degree of freedom (1 DoF) in the direction of their main axis (e.g. a bolt axis). Hence, the spherical bearings are only taking loads in their preferred radial load direction.
(30) The first to third spherical bearings connect the wing structure with the component support via lugs. At least one main axis of the spherical bearings (e.g. bolt axis) is orientated differently in relation to the other two main axes (e.g. bolt axes). This has the advantage that the attachment device is able to counteract the axial loads. According to an exemplary embodiment, the first axis of the first connecting means for establishing a front attachment and the second axis of the second connecting means which is one of two connecting means for establishing a rear attachment are oriented in the same direction, e.g. in the line of flight, and the third axis of the third connecting means which establishes together with the second connection means, the rear attachment, is oriented perpendicularly in relation to the first and second axes.
(31) Each connecting means may comprise a bolt. On each bolt, a spherical bearing may be mounted, to avoid the transfer of moment reactions. So overall, six reaction forces are transferred by the attachment device in space. Thus, the attachment device is isostatic.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) For an understanding of embodiments of the disclosure, reference is now made to the following description taken in conjunction with the accompanying drawings, in which:
(2) FIG. **1** is a perspective view of an aircraft with wings and several aircraft components such as control surfaces and engines carried by the wings;
(3) FIG. **2** is a top view of an embodiment of an aircraft component support arrangement with a component support for supporting an aircraft component and an attachment device for attaching the component support to the wing;
(4) FIG. **3** is a front view of the aircraft component support arrangement of FIG. **2**;
(5) FIG. **4** is a left side view of the aircraft component support arrangement of FIG. **2**;
(6) FIG. **5** is a sectional view along the plane A-A of the aircraft component support arrangement of FIG. **2**;
(7) FIG. **6** is a perspective view of the aircraft component support arrangement;
(8) FIG. **7** is a diagram illustrating a first to third connection means of the attachment device and loads and reaction forces acting thereon;
(9) FIG. **8** is a perspective view of the front part of the component support together with parts of the first to third connection means;
(10) FIG. **9** is a top view of a part of the component support for illustrating a rear attachment of the attachment device;
(11) FIG. **10** is a sectional view along the plane B-B of FIG. **9**; and
(12) FIG. **11** is an enlarged view of a detail of FIG. **10** illustrating a design of the connecting means.
DETAILED DESCRIPTION OF SOME EMBODIMENTS
(13) Some embodiments will now be described with reference to the Figures.
(14) FIG. **1** shows an embodiment of an aircraft **10** comprising a fuselage **12**, wings **14** and several aircraft components **16** carried by the wings **14**. Some examples for the aircraft components **16** are, but not limited to, engines **18** or control surface elements **20**, especially of a high-lift system **22**.

The control surface elements **20** comprise slats **24**, ailerons **26**, flaps **28**, speed brakes **30**, roll spoilers **32**, lift dumpers **34** and load alleviation function elements **36**.
(15) Each aircraft component **16** is supported on structure attached to the wing **14** which is referred to as component support **38** in the following. Some examples for the component support **38** include, but not limited to, an engine pylon **40** or a control surface element support **42**, such as a flap support **44**, for movably supporting one or several of the control surface elements **20**, e.g., one or several of the flaps **28**. In the following, an attachment concept for attaching the component support **38** to the associated wing **14** is explained, by way of example, with reference to an attachment of a flap support **44**. The same attachment concept is applicable to other component supports such as the engine pylon **40** or other control surface element supports **42**.
(16) Referring to FIGS. **2** to **6**, an aircraft component support arrangement **46** for connecting the aircraft component **16** to the aircraft wing **14** is shown. The component support arrangement **46** includes the component support **38**, e.g., the flap support **44**, and an attachment device **48**.
(17) The flap support **44** is configured to support a moving mechanism **50** for moving the flap **28** between a fully retracted and a fully extended position. In the embodiments shown, the flap support **44** includes a flap track **52** provided on a bifurcated flap support beam **54**. A flap carriage **56** is guided in the flap track **52**. The flap carriage **56** has a linkage **58** that is connected to the flap **28** (not shown here) in use.
(18) The attachment device **48** includes a first connecting means **60.1**, a second connecting means **60.2**, and a third connecting means **60.3**. The connecting means **60.1**, **60.2**, **60.3** are configured to connect the component support **38** to a wing structure **62** such as a wing box **64**.
(19) The first connecting means **60.1** comprises a first floating bearing **66.1** permitting linear movement in direction of a first axis **68.1** and angular rotation about a central point in two orthogonal directions, namely about the first axis **68.1** and a first transversal axis **70.1**. The second connecting means **60.2** comprises a second floating bearing **66.2** permitting linear movement in direction of a second axis **68.2** and angular rotation about a central point in two orthogonal directions, namely about the second axis **68.2** and about a second transversal axis **70.2**. The third connecting means **60.3** comprises a third floating bearing **66.3** permitting linear movement in direction of a third axis **68.3** and angular rotation about a central point in two orthogonal directions, namely about the third axis **68.3** and a third transversal axis **70.3**.
(20) A floating bearing is a bearing which only bears radial loads. In the axial direction it is able to compensate for longitudinal expansion of one of the connecting partners either by its inner geometry or through a sliding fit. Different designs are possible for the floating bearings **66.1**, **66.2**, **66.3**. In the embodiments shown, each of the floating bearings **66.1**, **66.2**, **66.3** include a bolt **72.1**, **72.2**, **72.3** to be connected to one of the connecting partners and a spherical bearing **74.1**, **74.2**, **74.3** that can be shifted linearly along the bolt axis defining the first to third axis **68.1**, **68.2**, **68.3** and that connects the bolt in a rotatable manner to the other connecting partner. In the embodiments shown, the bolts **72.1**, **72.2**, **72.3** are mounted to the component support **38**, i.e. the flap support **44**, while lugs **76.1**, **76.2**, **76.3** including the outer bearing shells of the spherical bearings **74.1**, **74.2**, **74.3** are mounted to the wing structure **62**.
(21) At least one of the first to third axes **68.1**, **68.2**, **68.3** has another orientation in relation to the other two of the first to third axes **68.1**, **68.2**, **68.3**. In the embodiments shown, the first and second axes **68.1**, **68.2** are oriented in the line of flight, while the third axis **68.2** is perpendicular thereto (e.g., in a horizontal direction).
(22) The attachment device **48** has a front attachment **78** constituted by the first connecting means **60.1** and a rear attachment **80** constituted by the second and third connecting means **60.2**, **60.3**. The second connecting means **60.2** is located on the inboard side of the component support **38**, while the third connecting means **60.3** is located on the outboard side of the component support **38**, in the embodiments shown, the second connecting means **60.2** connects an inboard rib **82** of the flap support beam **54** to the wing structure **62**, while the third connecting means **60.3** connects an

outboard rib **84** of the flap support beam **54** to the wing structure **54**.
(23) Thus, the connecting means **60.1**, **60.2**, **60.3** are located on three different connecting points arranged at the apexes of a triangle, as this is also illustrated in FIG. **7**.
(24) FIG. **7** shows the reaction forces for each bolt **72.1**, **72.2**, **72.3**. In FIG. **7**, the x-direction is the horizontal direction perpendicular to the line of flight, the y-direction is the direction in line of flight, and the z-direction is the vertical direction.
(25) FIG. **7** illustrates the main function of the three axes **68.1**, **68.2**, **68.3** of the bolts **72.1**, **72.2**, **72.3** with their spherical bearings **74.1**, **74.2**, **74.3**. Each spherical bearing **74.1**, **74.2**, **74.3** with the associated bolt **72.1**, **72.2**, **72.3** has a degree of freedom in axial direction, so the spherical bearings **74.1**, **74.2**, **74.3** are able to slide (move) along the bolt axis direction in case of local deformations or displacements.
(26) The attachment concept is based on three floating bearings **66.1**, **66.2**, **66.3** without any master bearing (e.g., a fixed bearing that defines a reference position), by aligning the axes **68.1**, **68.2**, **68.3** for counteracting all external loads. The wing attachment lugs **76.1**, **76.2**, **76.3** are able to slide on bolt bushes **86** in axial direction, because on each side of the lugs **76.1**, **76.2**, **76.3**, gaps **88** are provided or incorporated in the design (see FIG. **11**).
(27) Referring back to FIG. **7**, all connecting means **60.1**, **60.2**, **60.3** bear loads in their main radial direction. Hence, all connecting means **60.1**, **60.2**, **60.3** bear loads in the vertical direction. While the first and second connecting means **60.1**, **60.2** bear loads directed horizontally perpendicular to the line of flight, the third connecting means **60.3** bears loads in direction of line of flight. The arising of constraint loads under deformation of any of the connecting partners is avoided due to the different degrees of freedom of the connecting means **60.1**, **60.2**, **60.3**. The attachment device **48** consists of floating bearings **66.1**, **66.2**, **66.3** only and has no fixed bearings. The attachment device **48** is a fully isostatic system, and any reaction force is fully determined.
(28) Detailed exemplary embodiments of the connecting means **60.1**, **60.2**, **60.3** are shown in FIGS. **5**, and **8** to **10**, wherein FIGS. **5** and **10** and **11** are sectional views. As can be noted from these Figures, the rigging of the flap support beam **54** and its ribs **82**, **84** is performed with eccentric bushes **86** (alternatively, in further embodiments, not shown, with eccentric bolts **72.1**, **72.2**, **72.3**). For providing the axial sliding capability under deformation, the bushes **86** are configured as sliding bushes, and a gap **88** is provided between wing lugs on each side (see FIG. **11**). The bolt **72.1-72.3** is fixed with a nut **89**.
(29) While the main load in use is borne by the attachment device **48**, the concept easily allows an integration of a dual load path design. A second load path **90**, which functions as a “wating” fail safe load path that is not under load in normal operation is shown in FIGS. **2** to **5**.
(30) In order to improve the attachments of aircraft components **16** to an aircraft wing **14** with regard to simple design and better load distribution an aircraft component support arrangement **46** for connecting the aircraft component **16** to an aircraft wing **14** has been described. The aircraft component support arrangement **46** includes a component support **38** and an attachment device **48** for attaching the component support **38** to a wing structure **62**. The attachment device **48** comprises a first to third connection means **60.1**, **60.2**, **60.3** for connecting the component support **38** to the wing structure **62**, the first to third connection means **60.1**, **60.2**, **60.3** each comprising a floating bearing **66.1**, **66.2**, **66.3** permitting linear movement in direction of a first to third axis **68.1**, **68.2**, **68.3**, respectively, and angular rotation about a central point in two orthogonal directions, wherein the first to third connection means **60.1**, **60.2**, **60.3** are spaced apart from each other in two dimensions to connect the component support **38** at three different locations to the wing structure (**62** and wherein at least one of the first to third axes **68.1**, **68.2**, **68.3** has a different orientation to the others of the first to third axes **68.1**, **68.2**, **68.3**.
(31) While at least one exemplary embodiment is disclosed herein, it should be understood that modifications, substitutions and alternatives may be apparent to one of ordinary skill in the art and can be made without departing from the scope of this disclosure. This disclosure is intended to

cover any adaptations or variations of the exemplary embodiment(s). In addition, in this disclosure, the terms “comprise” or “comprising” do not exclude other elements or steps, the terms “a” or “one” do not exclude a plural number, and the term “or” means either or both. Furthermore, characteristics or steps which have been described may also be used in combination with other characteristics or steps and in any order unless the disclosure or context suggests otherwise. This disclosure hereby incorporates by reference the complete disclosure of any patent or application from which it claims benefit or priority.

Claims

1. An aircraft component support arrangement for connecting an aircraft component to an aircraft wing, including a component support and an attachment device for attaching the component support to a wing structure, the attachment device, comprising: a first connection means for connecting the component support to the wing structure, the first connection means consisting of a first bolt and a first floating bearing permitting linear movement in direction of a first axis and angular rotation about a central point in two orthogonal directions, a second connection means for connecting the component support to the wing structure, the second connection means consisting of a second bolt and a second floating bearing permitting linear movement in direction of a second axis and angular rotation about a central point in two orthogonal directions, a third connection means for connecting the component support to the wing structure, the third connection means consisting of a third bolt and a third floating bearing permitting linear movement in direction of a third axis and angular rotation about a central point in two orthogonal directions, wherein the first to third connection means are spaced apart from each other in two dimensions to connect the component support at three different locations to the wing structure, and wherein at least one of the first to third axes has a different orientation to the others of the first to third axes.
2. The aircraft component support arrangement according to claim 1, wherein the first and second axes are oriented parallel to each other and are spaced apart from each other wherein the third axis has at least one direction component perpendicular to the first and second axes.
3. The aircraft component support arrangement according to claim 1, wherein each of the first to third floating bearings comprises a spherical bearing.
4. The aircraft component support arrangement according claim 3, wherein the spherical bearing is movable in direction of the bolt axis and has a lug configured to be connected to the other of the component support and the wing structure.
5. The aircraft component support arrangement according to claim 1, wherein the first connection means is part of a front attachment of the component support, and the second and third connection means are parts of a rear attachment of the component support.
6. The aircraft component support arrangement according to claim 1, wherein the component support is chosen from the group consisting of a control surface element support for movably supporting a control surface element, a high-lift control surface element for movably supporting a control surface element of a high-lift system, a flap support for movably supporting a flap moving mechanism of a flap, and an engine pylon.
7. The aircraft component support arrangement according to claim 1, wherein the first and second axes are directed in the flight direction and are spaced apart from each other in spanwise direction and/or in that the third axis is directed in a horizontal direction and/or has at least a component directed in the spanwise direction.
8. A high-lift system for an aircraft, comprising a high-lift control surface element and an aircraft component support arrangement according to claim 1, wherein the aircraft component support arrangement is configured to movably support the high-lift control surface element.
9. The high-lift system according to claim 8, wherein the high-lift control surface element is a flap and the aircraft component support arrangement is configured to movably support the flap on a

trailing edge region of the aircraft wing.

10. An aircraft, comprising the high-lift system according to claim 8.

11. An aircraft wing, comprising an aircraft wing structure and the aircraft component support arrangement according to claim 1, wherein the aircraft component support arrangement is configured to connect an aircraft component to the aircraft wing.

12. The aircraft wing according to claim 11, wherein the aircraft component is a flap, wherein the aircraft component support arrangement supports a flap moving mechanism for moving the flap and is attached to the wing structure by means of the attachment device.

13. An aircraft, comprising the aircraft component support arrangement according to claim 1.

14. An aircraft, comprising the aircraft wing according to claim 11.