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Pneumatically Activated Coupled Experimental Retention System

Abstract

A fastening system including a plurality of male fasteners and a plurality of female fasteners, where each one of the male fasteners is configured and positioned to be inserted into one of the female fasteners. An air delivery subsystem configured to deliver air to the male and female fasteners in a manner that simultaneously actuates the plurality of male fasteners and simultaneously actuates the plurality of female fasteners so as to simultaneously couple and decouple the male and female fasteners. In one embodiment, the male fasteners are mounted to an aircraft access panel and the female fasteners are mounted to an aircraft body.

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Background/Summary

BACKGROUND

Field

[0001] This disclosure relates generally to a fastener assembly including a male fastener and a female fastener and, more particularly, to a fastener assembly including a male fastener and a female fastener that are pneumatically controlled to secure the fasteners together, where a common pneumatic line simultaneously controls a series of the male fasteners and a common pneumatic line simultaneously controls a series of the female fasteners.

Discussion of the Related Art

[0002] Modern aircraft, both commercial and military, often include a number of access panels that allow maintenance workers and the like to gain access to various aircraft systems and devices. These panels are typically secured to the aircraft body by screws or other fastening devices in a manner so that heads of the screws do not extend beyond the outer mold line (OML) of the body so as to maintain aerodynamic efficiency. Often times many screws are necessary to provide the desired panel closing integrity and reliability. Thus, it is a very labor intensive process to remove the screws to remove the panel and to insert the screws to reattach the panel.

SUMMARY

[0003] The following discussion discloses and describes a fastener assembly including a male fastener and a female fastener that are pneumatically controlled to secure the fasteners together. The male fastener includes a hollow body having a mounting end and an insertion end and defining a chamber therein. The male fastener further includes a slidable piston positioned in the chamber and having a threaded bore facing the insertion end, and a cam shaft having a threaded tip threaded into the threaded bore in the male piston, a wide portion including a recess facing the insertion end and a tapered portion between the threaded tip and the wide portion. The male fastener also includes a port in fluid communication with the chamber between the mounting end and the piston, a plurality of spring-loaded pins slidably extending through pin orifices in the hollow body into the chamber along a radial axis substantially perpendicular to the cam shaft, where each pin includes a nub having a diameter larger than the pin orifice that rides on the cam shaft, and a spring positioned in the recess and against the insertion end. The female fastener includes a hollow body having a mounting end and an open end with a flange and defining a chamber therein. The female fastener further includes a slidable piston positioned in the chamber and having a threaded bore facing the open end, an annular retention collar having a rim at one end and a threaded post at an opposite end that is threaded into the threaded bore in the female piston and extends out of the open end of the hollow body. The female fastener also includes a port in fluid communication with the chamber between the mounting end and the piston, and a spring positioned around the retention collar between the flange and the piston.

[0004] Applying air pressure to the port in the male fastener causes the piston and the cam shaft to move towards the insertion end of the hollow body against the bias of the spring, which causes the pin nubs to ride on the cam shaft from the wide portion along the tapered portion to retract the pins into the hollow body to allow the insertion end to be inserted into the retention collar. Applying air pressure to the port in the female fastener causes the piston to move the retention collar farther out of the hollow body against the bias of the spring. Insertion of the insertion end of the male fastener into the retention collar with the pins retracted allows the pins to then be extended and positioned under the rim under the bias of the spring when air pressure is removed from the port and then allows the rim to engage the pins and pull the pins and thus the male fastener towards the hollow body of the female fastener under the bias of the spring when air pressure is removed from the port in the female fastener.

[0005] Additional features of the disclosure will become apparent from the following description and appended claims, taken in conjunction with the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** is a broken-away view of an aircraft showing an access panel at an underside location of the aircraft fuselage;

[0007] FIG. **2** is an isometric view of a fastener assembly including a male fastener and a female fastener;

[0008] FIGS. **3**-**6** are cross-sectional type isometric views of the fastener assembly in various stages of coupling between the male and female fasteners;

[0009] FIG. **7** is an isometric view of an aircraft access panel including a fastening system made up of a series of the male fasteners interconnected by a common pneumatic line; and

[0010] FIG. **8** is an isometric view of an aircraft body including a fastening system made up of a series of the female fasteners interconnected by a common pneumatic line.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0011] The following discussion of the embodiments of the disclosure directed to a fastener assembly including a male fastener and a female fastener that are pneumatically controlled to secure the fasteners together is merely exemplary in nature, and is in no way intended to limit the disclosure or its applications or uses. For example, the discussion herein describes the fastening system as having application for fastening an access panel to an aircraft body. However, as will be appreciated by those skilled in the art, the fastening system will have other applications.

[0012] FIG. **1** is a broken-away view of an aircraft **10** including a fuselage **12** having an access panel **14** mounted to an underside of the fuselage **12**. As will be discussed in detail below, the access panel **14** can be secured to the fuselage **14** by a pneumatically activated mechanical fastening system.

[0013] FIG. **2** is an isometric view of a fastener assembly **20** that is part of the fastening system referred to above. The fastener assembly **20** includes a male fastener **22** and a female fastener **24**, where the male fastener **22** may be mounted to the access panel **14** and the female fastener **24** may be mounted to the fuselage **12** in this non-limiting example. The male fasteners **22** are all attached under the OML of the aircraft **10**, and thus the exposure of the male fasteners **22** to the OML of the aircraft **10** is reduced, which has aero and other technical advantages. The male fastener **22** includes a cylindrical hollow body **28** made of, for example, stainless steel and having an endcap **38** secured to an end of the body **28** with bolts **26**. A series of spring-loaded pins **30**, here six, are symmetrically disposed around an end of the body **28** proximate the endcap **38** on a common plane and a mounting plate **32** including bolt holes **34** is formed to an opposite end of the body **28**. The female fastener **24** includes a cylindrical hollow body **36** made of, for example, stainless steel that is open at a top end to accept the body **28** of the male fastener **22**. A retention collar **40** including an angled or undercut rim **42** is disposed within the body **36** of the female fastener **24** and partially extends therefrom through an annular flange **48**. The female fastener **24** also includes a mounting plate **44** having bolt holes **46** formed to a bottom end of the body **36**.

[0014] FIGS. **3**-**6** are cross-sectional type isometric views of the fastener assembly **20** shown in various stages of coupling. FIG. **3** shows the male fastener **22** and the female fastener **24** separated from each other as shown in FIG. **2** in a state where the access panel **14** is ready to be coupled to the fuselage **12**.

[0015] The body **28** of the male fastener **22** includes a chamber **50** at the bottom end of the body **28** and a chamber **52** at the top end of the body **28** that are separated by a slidable piston **54** having a threaded bore **58** facing the chamber **52**. In one non-limiting embodiment, the piston **54** is made of Delrin or acytel resin and has a flexible skirt **82** that is forced outward against the inside walls of the body **28** as air pressure increases. A threaded port **56** extends through the body **28** to be in fluid communication with the chamber **50**, and allows for commercial off the shelf (COTS) pneumatic

fittings to be secured thereto. A cam shaft **60** extends through the chamber **52** and through a center opening **62** of an annular pin guide **64**. The cam shaft **60** includes a narrow diameter cylindrical portion **66** having a threaded tip **68** that is threaded into the bore **58** in the piston **54**, a wide diameter cylindrical portion **70** including an annular recess **72** and a tapered portion **74** therebetween. A spring **76** is positioned in the recess **72** and against the endcap **38**. A plug **84** is inserted through the plate **32** and into the chamber **50** and operates as a stop to prevent the piston **54** from pressing into an air fitting (see FIG. **7**) that is threaded into the port **56**. The pins **30** extend into the chamber **52** along a radial axis substantially perpendicular to the cam shaft **60** and include an end nub **78** that rides along the cam shaft **60** when the piston **54** moves. The pins **30** extend through pin orifices **80** that are sized so that the nub **78** is unable to pass through.

[0016] The body **36** of the female fastener **24** includes a chamber **90**. A piston **92** is positioned within the chamber **90** and includes a threaded bore **94**. In one non-limiting embodiment, the piston **92** is made of Delrin or acytel resin and has a flexible skirt **88** that is forced outward against the inside walls of the body **36** as air pressure increases. The retention collar **40** includes a threaded post **96** that is threaded into the bore **94** in the piston **92** to secure the collar **40** thereto. A spring **86** is positioned in the chamber **90** between the piston **92** and the flange **48** and encircles the collar **40**. A threaded port **98** extends through the mounting plate **44** and is in fluid communication with the chamber **90**, and allows for COTS pneumatic fittings to be secured thereto.

[0017] The following procedure is followed to couple the male fastener **22** to the female fastener **24**. When the fastener assembly **20** is in the state shown in FIG. **3**, air pressure is applied to the port **56** and into the chamber **50**, which causes the piston **54** and the cam shaft **60** to be pushed down against the bias of the spring **76**. As the shaft **60** moves, the nubs **78** ride along the tapered portion **74** of the shaft **60** so that the spring loaded pins **30** retract into the body **28**. At or about the same time, air pressure is applied to the port **98**, which causes the piston **92** to move up against the bias of the spring **86** and extend the retention collar **40** further out of the body **36**. This position of the fastener assembly **20** is shown in FIG. **4**. The body **28** of the male fastener **22** is then inserted into the retention collar **40**, manually or otherwise, far enough so that the retracted pins **30** are below the rim **42** of the retention collar **40**. The air pressure being applied to the port **56** is released, which causes the shaft **60** to rise under the bias of the spring **76**, which cause the pins **30** to be pushed out of the orifices **80** against their spring-loaded bias and be positioned under the rim **42**. This position of the fastener assembly **20** is shown in FIG. **5**. The air pressure is then released from the port **98**, which causes the spring **86** to push the piston **92** down, which causes the rim **42** to engage the pins **30** and pull the male fastener **22** down and lock the fasteners **22** and **24** together. This position of the fastener assembly **20** is shown in FIG. **6**. The fastener assembly **20** is in the locked position with no air pressure being applied to the ports **56** and **98**, and thus is in a fail safe mode. The process to decouple the male fastener **22** from the female fastener **24** is accomplished in the reverse order, as described.

[0018] FIG. **7** is an isometric view of an aircraft access panel **100**, representing the panel **14**, including a fastening system **102** having a series of the male fasteners **22** bolted to the panel **100**, where suitable fittings **104** are coupled to the ports **56** and a common pneumatic line **106** is coupled to the fittings **104** and a single air source **108**.

[0019] Likewise, FIG. **8** is an isometric view of a portion of an aircraft body **110** illustrating a fastening system **112** coupled to the body **110** by a support structure **114** surrounding an opening **122**. The fastening system **112** includes a series of the female fasteners **24** bolted to the support structure **114**, where suitable fittings **116** are coupled to the ports **98** and a common pneumatic line **118** is coupled to the fittings **116** and a single air source **120**.

[0020] Air from the source **108** is simultaneously provided to the fasteners **22** and air from the source **120** is simultaneously provided to the fasteners **24** in the manner described above to connect and disconnect the fasteners **22** and **24**. When attaching the fasteners **22** and **24**, a worker will manually position the panel **100** in the opening **122** in the body **110** so that the fasteners **22** and **24**

align for the step shown in FIG. **5**.

[0021] The foregoing discussion discloses and describes merely exemplary embodiments of the present disclosure. One skilled in the art will readily recognize from such discussion and from the accompanying drawings and claims that various changes, modifications and variations can be made therein without departing from the spirit and scope of the disclosure as defined in the following claims.

Claims

1. A fastening assembly comprising: a male fastener including a hollow cylindrical male body having a mounting male end and an insertion end and defining a male chamber therein, said male fastener further including a slidable male piston positioned in the male chamber and having a threaded male bore facing the insertion end, a cam shaft having a threaded tip threaded into the threaded male bore in the male piston, a wide portion including a recess facing the insertion end and a tapered portion between the threaded tip and the wide portion, a male port in fluid communication with the male chamber between the mounting male end and the male piston, a plurality of spring-loaded pins slidably extending through pin orifices in the hollow male body into the male chamber along a radial axis substantially perpendicular to the cam shaft, where each pin includes a nub having a diameter larger than the pin orifice that rides on the cam shaft, and a male spring positioned in the recess and against the insertion end; and a female fastener including a hollow cylindrical female body having a mounting female end and an open end with a flange and defining a female chamber therein, said female fastener further including a slidable female piston positioned in the female chamber and having a threaded female bore facing the open end, an annular retention collar having a rim at one end and a threaded post at an opposite end that is threaded into the threaded female bore in the female piston and extends out of the open end of the hollow female body, a female port in fluid communication with the female chamber between the mounting female end and the female piston, and a female spring positioned around the retention collar between the flange and the female piston, wherein applying air pressure to the male port causes the male piston and the cam shaft to move towards the insertion end of the hollow male body against the bias of the male spring, which causes the pin nubs to ride on the cam shaft from the wide portion along the tapered portion to retract the pins into the hollow male body to allow the insertion end to be inserted into the retention collar, and wherein applying air pressure to the female port causes the female piston to move the retention collar farther out of the hollow female body against the bias of the female spring, and wherein insertion of the insertion end into the retention collar with the pins retracted allows the pins to then be extended and positioned under the rim under the bias of the male spring when air pressure is removed from the male port and then allows the rim to engage the pins and pull the pins and thus the male fastener towards the hollow female body under the bias of the female spring when air pressure is removed from the female port.

2. The fastener assembly according to claim 1 wherein the plurality of pins is six pins.

3. The fastener assembly according to claim 1 wherein the mounting male and female ends include a mounting plate having bolt holes.

4. The fastener assembly according to claim 1 wherein the male fastener further includes an annular pin guide positioned in the male chamber proximate the pins, said cam shaft extending through a central opening in the annular pin guide.

5. The fastener assembly according to claim 1 wherein the male fastener is configured to be mounted to an access panel on an aircraft and the female fastener is configured to be mounted to a fuselage on the aircraft.

6. A fastening system comprising: a plurality of male fasteners each including a hollow body having a mounting end and an insertion end and defining a chamber therein, each male fastener further including a slidable piston positioned in the chamber and having a threaded bore facing the

insertion end, a cam shaft having a threaded tip threaded into the threaded bore in the piston, a wide portion including a recess facing the insertion end and a tapered portion between the threaded tip and the wide portion, a port in fluid communication with the chamber between the mounting end and the piston, a plurality of spring-loaded pins slidably extending through pin orifices in the hollow body into the chamber along a radial axis substantially perpendicular to the cam shaft, where each pin includes a nub having a diameter larger than the pin orifice that rides on the cam shaft, and a spring positioned in the recess and against the insertion end; and an air delivery subsystem including an air fitting coupled to each port, at least one air hose coupled to the air fittings and an air source coupled to the at least one air hose, wherein applying air pressure from the air source to the at least one air hose and to each of the air fittings simultaneously causes in each of the male fasteners the piston and the cam shaft to move towards the insertion end of the hollow body against the bias of the spring, which causes the pin nubs to ride on the cam shaft from the wide portion along the tapered portion to retract the pins into the hollow body.

7. The fastening system according to claim 6 wherein the plurality of pins is six pins.

8. The fastening system according to claim 6 wherein the mounting end includes a mounting plate having bolt holes.

9. The fastening system according to claim 6 wherein the male fastener further includes an annular pin guide positioned in the chamber proximate the pins, said cam shaft extending through a central opening in the annular pin guide.

10. The fastening system according to claim 6 wherein the male fastener is configured to be mounted to an access panel on an aircraft.

11. A fastening system comprising: a plurality of female fasteners each including a hollow body having a mounting end and an open end with a flange and defining a chamber therein, each female fastener further including a slidable piston positioned in the chamber and having a threaded bore facing the open end, an annular retention collar having a rim at one end and a threaded post at an opposite end that is threaded into the threaded bore in the piston and extends out of the open end of the hollow body, a port in fluid communication with the chamber between the mounting end and the piston, and a spring positioned around the retention collar between the flange and the piston; and an air delivery subsystem including an air fitting coupled to each port, at least one air hose coupled to the air fittings and an air source coupled to the at least one air hose, wherein applying air pressure from the air source to the at least one air hose and to each of the air fittings simultaneously causes in each of the female fasteners the piston to move the retention collar farther out of the hollow body against the bias of the spring.

12. The fastening system according to claim 11 wherein the mounting end includes a mounting plate having bolt holes.

13. The fastening system according to claim 11 wherein the female fastener is configured to be mounted to an aircraft fuselage.

14. A fastening system comprising: a plurality of male fasteners each including a hollow male body having a mounting male end and an insertion end and a male port in fluid communication with the hollow male body; a male air delivery subsystem including a male air fitting coupled to each male port, at least one male air hose coupled to the male air fittings and a male air source coupled to the at least one male air hose, wherein applying air pressure from the male air source to the at least one male air hose and to each of the air fittings simultaneously actuates the plurality of male fasteners; a plurality of female fasteners each including a hollow female body having a mounting female end and an open end and a female port in fluid communication with the hollow female body; and a female air delivery subsystem including a female air fitting coupled to each female port, at least one female air hose coupled to the female air fittings and a female air source coupled to the at least one female air hose, wherein applying air pressure from the female air source to the at least one female air hose and to each of the female air fittings simultaneously actuates each of the female fasteners.

15. The fastening system according to claim 14 wherein each male fastener further includes a slidable piston positioned in the hollow male body and having a threaded bore facing the insertion end, a cam shaft having a threaded tip threaded into the threaded bore in the piston, a wide portion including a recess facing the insertion end and a tapered portion between the threaded tip and the wide portion, a plurality of spring-loaded pins slidably extending through pin orifices in the hollow body into the hollow male body along a radial axis substantially perpendicular to the cam shaft, where each pin includes a nub having a diameter larger than the pin orifice that rides on the cam shaft, and a spring positioned in the recess and against the insertion end.
16. The fastening system according to claim 15 wherein the plurality of pins is six pins.
17. The fastening system according to claim 15 wherein each male fastener further includes an annular pin guide positioned in the chamber proximate the pins, said cam shaft extending through a central opening in the annular pin guide.
18. The fastening system according to claim 14 wherein each female fastener further includes a slidable piston positioned in the hollow female body and having a threaded bore facing the open end, an annular retention collar having a rim at one end and a threaded post at an opposite end that is threaded into the threaded bore in the piston and extends out of the open end of the hollow female body, and a spring positioned around the retention collar.
19. The fastener system according to claim 14 wherein the mounting male and female ends include a mounting plate having bolt holes.
20. The fastener system according to claim 14 wherein the male fasteners are configured to be mounted to an access panel on an aircraft and the female fasteners are configured to be mounted to a fuselage on the aircraft.