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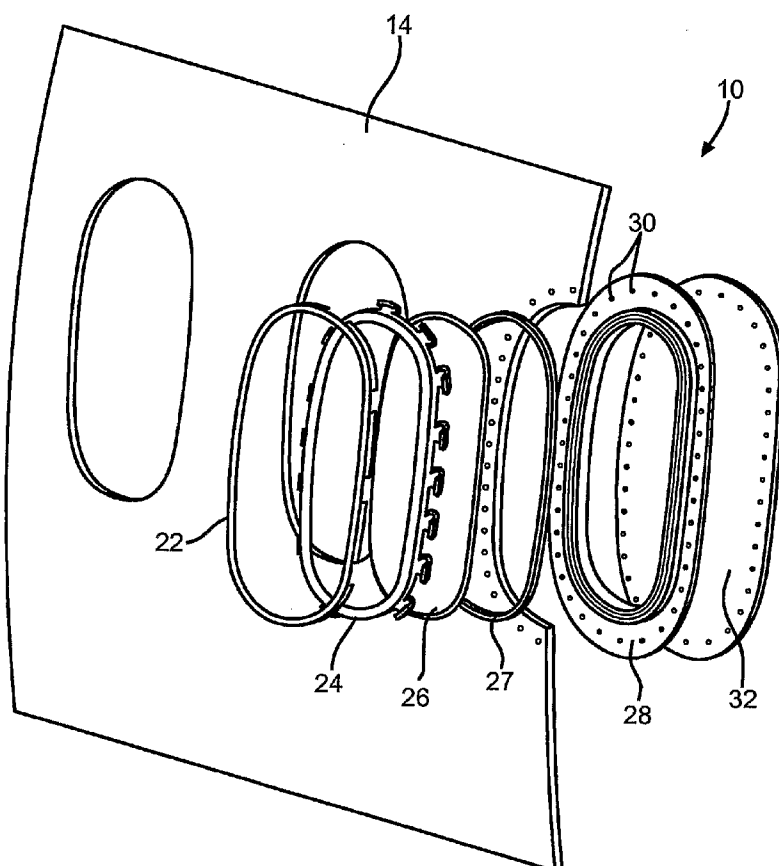
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(54) Title: WINDOW ASSEMBLY RETAINING SYSTEM



(57) Abstract: A window assembly and method for its installation is provided. The window assembly may include multiple transparent panels covering an opening of an aircraft fuselage. One or more retainer members and a flexible clip member may be utilized to secure the window assembly over the opening of the fuselage.

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WINDOW ASSEMBLY RETAINING SYSTEM

BACKGROUND OF THE INVENTION

[001] Most current passenger aircraft window systems comprise multiple panes of acrylic that are coupled together in a multi-piece sheet metal attachment structure. Typically, this structure is installed from the interior of the aircraft and is not maintenance friendly since the passenger seats and aircraft interior wall fascia panels must be removed for access to the window system. Often, the window systems require a deep envelope in the fuselage to accommodate the bulky sheet metal structure holding the multi-pane window.

[002] Many next generation aircraft incorporate transparent structural panels fastened around apertures in the fuselage skin to allow occupants of the aircraft to look through the transparent panels. The panels are typically attached directly to the inside of the fuselage skin. These panels often require external fairing panes to fill in the gap between the inside surface of the skin and the outside surface of the skin in order to provide an aerodynamically smooth surface on the outside surface of the fuselage. The external fairing panes may provide for noise abatement, a thermal barrier, and an abrasion resistant barrier for the internally mounted transparent panel.

[003] The fairing pane attachment system for these next generation aircraft typically must fit inside an envelope equal to the thickness of the fuselage skin, and be capable of allowing installation of the fairing pane from the outside surface of the aircraft fuselage for quick replacement and easy maintenance. Conventional solutions for attaching the outer protective fairing pane have typically been to utilize a picture frame

to encase the fairing pane, and fasteners for attachment to the aircraft structure.

However, utilizing a picture frame, which generally comprises a raised step around the fairing pane aperture, may not supply a smooth aerodynamic surface on the exterior surface of the fuselage, and may induce drag and reduce performance. Moreover, attachment of fasteners is usually required. Installation of fasteners may be time consuming, may require torque specifications for proper attachment, and may require a maintenance person to remove gloves in order to perform necessary maintenance. Additionally, fasteners may be dropped during maintenance and may cause foreign object damage (FOD) to aircraft systems.

[004] A window assembly and method for its installation is required which will allow for efficient installation of fairing panes from the outside of the aircraft fuselage in a space-challenged envelope. This window assembly may also be utilized in non-aircraft applications.

SUMMARY OF THE INVENTION

[005] In one aspect of the present invention, a window assembly for an aircraft fuselage comprises a first transparent panel, a second transparent panel, a first retainer member defined by at least one hole, and a flexible clip member. The first transparent panel covers at least a portion of an opening in the aircraft fuselage. At least a portion of the flexible clip member extends into the hole.

[006] In another aspect of the present invention, a window assembly for an aircraft fuselage comprises a first retainer member, a flexible clip member, and a first transparent panel. The first transparent panel is adapted to be fixedly secured in a

location when a portion of the flexible clip member is in one of an extended position and a compressed position. Similarly, the first transparent panel is adapted to be released from the location when the portion of the flexible clip member is in the other of the extended position and the compressed position.

[007] In a further aspect of the present invention, a method is provided for forming a window assembly on an aircraft fuselage having an opening. A first transparent panel is placed over at least a portion of the opening. A first retainer member is placed over at least a portion of the first transparent panel. The configuration of the flexible clip member is changed to secure the second transparent panel in a position.

[008] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[009] Figure 1 is a perspective view of an aircraft incorporating a window assembly in accordance with the present invention;

[010] Figure 2 is an enlarged plan view of one of the windows of the aircraft of Figure 1;

[011] Figure 3 is an exploded perspective view of the window assembly shown in Figure 2;

[012] Figure 4 is a perspective view of the dotted line area of Figure 2 showing a retaining frame and fairing pane being installed utilizing a retaining fitting;

[013] Figure 5 is a partial cross-sectional view along lines 5-5 of Figure 4.;

[014] Figure 6 is a top view of the clip member in the dotted line area of Figure 4 showing the configuration of the clip member in an extended position; and

[015] Figure 7 is a top view of the clip member of Figure 6 showing the configuration of the clip member in a compressed position.

DETAILED DESCRIPTION OF THE INVENTION

[016] The following detailed description is of the best currently contemplated modes of carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention, since the scope of the invention is best defined by the appended claims.

[017] Referring to Figure 1, a plurality of window assemblies 10, in accordance with a preferred embodiment of the present invention, are illustrated as incorporated into a fuselage 12 of an airplane 14. The structural and operational properties of the window assembly 10 are especially well suited for use with aircraft, where the window assembly 10 is exposed to significant changes in thermal conditions and air pressure, as well as impacts from foreign objects. In other embodiments, the window assembly 10 may be implemented in non-aircraft applications, such as buses, trains, and ships.

[018] Figure 2 depicts an enlarged view of one of the window assemblies 10. The window assembly 10 is held to the fuselage 14 by a plurality of fastening elements 16 spaced circumferentially around an opening 18 in which the window assembly 10 is installed. The fastening elements 16 extend through pre-formed openings in the fuselage 14.

[019] Figure 3 shows an exploded perspective view of the principal components of the

window assembly 10. The outer seal 22 is aerodynamic and helps to prevent foreign material and liquid from penetrating the window assembly 10. The outer seal 22 is made of neoprene, but in other embodiments may be made of other sealing material known in the art such as silicone. The retaining frame 24, also referred to as a retainer member, encases the periphery of the fairing pane 26. Preferably, the retaining frame 24 is made of stainless steel, but in other embodiments may comprise any type of steel or plastic known to those of ordinary skill in the art. The fairing pane 26, also referred to as a transparent panel, is preferably glass, but in other embodiments, may comprise any transparent material known in the art. The retaining frame 24, fairing pane 26, and silicone seal 27 are disposed over a machined, annular, retaining fitting 28, also referred to as a retainer member. The retaining fitting 28 is made of a metallic such as aluminum, but in other embodiments may be made of any material known in the art. Holes 30 surround the retaining fitting 28 for bolting the retaining fitting 28 and the internal transparent panel 32 to the airplane's fuselage 14. The internal transparent panel 32 is preferably a composite, but in other embodiments may comprise any transparent material known in the art.

[020] Figures 4 and 5 illustrate the connection of the fuselage 14, outer seal 22, retaining frame 24, fairing pane 26, silicone seal 27, retaining fitting 28, and transparent panel 32. Figure 4 is a perspective view of the dotted line area of Figure 2 showing the retaining frame 24 and fairing pane 26 being installed utilizing the retaining fitting 28. Figure 5 is a partial cross-sectional view along lines 5-5 of Figure 4. The outer seal 22 provides access to the window assembly 10 when removed from the fuselage 14. As shown, a portion 33 of the retaining fitting 28 is fixedly disposed between the fuselage

14 and transparent panel 32. The retaining fitting 28 comprises a curved surface 31 and a boss member 34. The boss member 34 is attached to the curved surface 31 utilizing Titanium rivets 35. An internal, T-slot trough 36 defines the boss member 34. In other embodiments, the boss member 34 may be attached to the curved surface 31 utilizing any mechanism known in the art, or the curved surface 31 and boss member 34 may comprise an integral piece. In additional embodiments, the retaining fitting 28 may comprise a plurality of boss members 34, each defined by troughs 36. In still other embodiments, the trough 36 may be in any configuration.

[021] The curved surface 31 of the retaining fitting 28 extends into a pressure-sealed cavity 29 in the fuselage 14. A portion 25 of the fairing pane 26 is disposed over a linear portion 37 of the retaining fitting 28. The silicone seal 27 is disposed between a portion 25 of the fairing pane 26 and the linear portion 37 of the retaining fitting 28. A portion 23 of the retaining frame 24 is disposed over the silicone seal 27 and fairing pane 26. Intermittent curved tabs 46 extend around the periphery of the retaining frame 24. A plurality of stainless steel, flexible, serpentine, wire, spring clips 38 are disposed intermittently inside the trough 36 around the perimeter of the retaining fitting 28. Preferably, twelve to fourteen flexible spring clips 38 are utilized, but in other embodiments, a varying number of clips made of varying materials may be utilized. A curved portion 40 of each flexible clip 38 is extended through a corresponding hole 42 in boss member 34 to allow the curved portion 40 of the flexible clip 38 to protrude past boss surface 43. Surfaces 44 within the T-slot trough 36 of the boss member 34 retain the flexible clips 38 in place within the trough 36. An end 48 of each curved tab 46 abuts against the extended portion 40 of the corresponding flexible clip 38. When the

window assembly 10 is aligned in this configuration, the fairing pane 26 is secured in place with respect to the airplane's fuselage 14 due to the retaining frame 24 being fixed in place as a result of its abutment against the flexible clips 38. The use of multiple independent flexible clips 38 provides for a means of redundant retention to accommodate for the possibility that a clip 38 is not properly installed or fails in service. The shape of the clips 38 allows the clips 38 to act in double shear to reduce shear loads on each clip 38.

[022] During installation of the window assembly 10, the transparent panel 32 is placed over an opening of the aircraft fuselage 14. Preferably, the transparent panel 32 is placed inside of the aircraft fuselage 14, but in other embodiments, varying configurations may be used. The retaining fitting 28 is located over at least a portion of the transparent panel 32 and secured in place against the fuselage 14. Next, the fairing pane 26 is placed over at least a portion of the retaining fitting 28. Preferably, the portion 37 of the retaining fitting 28 over which the fairing pane 26 is placed is linear. The retaining frame 24 is placed over at least a portion 37 of the fairing pane 26. Preferably, a seal 27 is utilized between the retaining frame 24 and fairing pane 26. One or more flexible clips 38 are slid into one or more T-slot troughs 36 of one or more boss members 34 of the retaining fitting 28. The curved portion 40 of the flexible clip 38 is extended through a corresponding hole 42 in the boss member 34 to allow the curved portion 40 of the flexible clip 38 to protrude past boss surface 43 as shown in Figure 6. The flexible clip 38 may also be inserted into the trough 36 before the window assembly 10 is installed in the aircraft. An end 48 of the curved tab 46 is downwardly abutted against an extended portion 40 of the flexible clip 38 to force the extended portion 40 of

the flexible clip 38 to compress towards the hole 42. In such manner, the configuration of the flexible clip 38 is changed into the position depicted by Figure 7. Once the end 48 of the curved tab 46 is fully past the flexible clip 38, the portion 40 of the flexible clip 38 re-extends away from the hole 42 to put the flexible clip back in the configuration shown in Figure 6. In such manner, the end 48 of the curved tab 46 of the retaining frame 24 is abutted against the extended portion 40 of the flexible clip 38 preventing the retaining frame 24 from moving upwardly. As a result, the retaining frame 24, and hence the fairing pane 26, are locked in place.

[023] To remove the fairing pane 26, the outer seal 22 is removed from the aircraft. A tool, such as a flat blade or the tip of a screwdriver, is inserted into the T-slot trough 36 against a surface of the flexible clip 38. The tool is used to force the flexible clip 38 to slide along the trough 36 to locate the flexible clip 38 back into the configuration shown in Figure 7, thereby compressing the extended portion 40 of the flexible clip 38 towards the hole 42. When the extended portion 40 of the flexible clip 38 is compressed, the retaining frame 24 may be removed allowing access to the fairing pane 26. In such manner, the fairing pane 26 may be removed without disassembling the entire window. A new fairing pane 26 may be installed by replacing the silicone seal 27, and sliding the flexible clip 38 back into its engaged position so that the extended portion 40 of the flexible clip 38 is re-extended away from the hole 42 back into its configuration of Figure 6.

[024] In other embodiments, one or more flexible clips 38 may be utilized in a variety of configurations and locations, utilizing differing expansion and compression mechanisms for various portions of the flexible clips 38, to secure and un-secure a variety of parts of

the window assembly. In still other embodiments, differing configurations, locations, assembly mechanisms, and expansion and compression mechanisms may be used for the various parts of the present invention.

[025] The invention may allow for a fairing pane 26 to be installed or replaced without the use of fasteners, and without the use of costly tools. As a result, the invention may allow for more time effective, efficient, and less costly installation and maintenance of window assemblies.

[026] It should be understood, of course, that the foregoing relates to exemplary embodiments of the invention and that modifications may be made without departing from the spirit and scope of the invention as set forth in the following claims.

WE CLAIM:

1. A window assembly for an aircraft fuselage comprising:
a first transparent panel covering at least a portion of an opening in the aircraft fuselage;
a second transparent panel;
a first retainer member defined by at least one hole; and
a flexible clip member having at least a portion of said clip member extending into said hole.
2. The window assembly of claim 1, wherein at least one of said first and second transparent panels is made of one of glass and a composite.
3. The window assembly of claim 1, wherein at least a portion of said first retainer member is disposed between said first transparent panel and an outer surface of said aircraft fuselage.
4. The window assembly of claim 1, wherein said first retainer member is made of a metallic.
5. The window assembly of claim 1, wherein said first retainer member extends around said opening.
6. The window assembly of claim 1, wherein said first retainer member

comprises at least one boss member, and said at least one hole is defined in said at least one boss member.

7. The window assembly of claim 6, wherein said at least one boss member is defined by a trough.

8. The window assembly of claim 7, wherein at least a portion of said clip member is disposed in said trough.

9. The window assembly of claim 1, wherein at least a portion of said clip member is adapted to extend out of said hole in one position and towards said hole in another position.

10. The window assembly of claim 1 further comprising a second retainer member.

11. The window assembly of claim 10, wherein said second retainer member is adapted to be fixedly secured in a location when a portion of said flexible clip member is in one of an extended position and a compressed position, and said second retainer member is adapted to be released from said location when said portion of said flexible clip member is in the other of said extended position and said compressed position.

12. A window assembly for an aircraft fuselage comprising:
- a first retainer member;
 - a flexible clip member; and
 - a first transparent panel, wherein said first transparent panel is adapted to be fixedly secured in a location when a portion of said flexible clip member is in one of an extended position and a compressed position, and said first transparent panel is adapted to be unsecured from said location when said portion of said flexible clip member is in the other of said extended position and said compressed position.
13. The window assembly of claim 12, wherein said first retainer member comprises at least one boss member defined by a trough.
14. The window assembly of claim 13, wherein said flexible clip member is adapted to slide within said trough.
15. The window assembly of claim 12, wherein said first retainer member is defined by at least one hole, and at least a portion of said flexible clip member extends into said hole.
16. The window assembly of claim 15, wherein when said portion of said flexible clip member is in said extended position at least a segment of said flexible clip member is extended past an outer surface of said first retainer

member.

17. The window assembly of claim 15, wherein when said portion of said flexible clip member is in a compressed position at least a segment of said flexible clip member is retracted towards said hole.

18. The window assembly of claim 12, wherein said portion of said flexible clip member is adapted to move from said extended position to said compressed position when a flat surface is abutted against the flexible clip member.

19. The window assembly of claim 12 further comprising a second transparent panel.

20. The window assembly of claim 12 further comprising a second retainer member.

21. A method for forming a window assembly on an aircraft fuselage having an opening comprising:

placing a first transparent panel over at least a portion of said opening;

placing a first retainer member over at least a portion of said first transparent panel; and

changing the configuration of a flexible clip member to secure a second

transparent panel in a position.

22. The method of claim 21 further comprising the step of placing said second transparent panel over at least a portion of said first retainer member.

23. The method of claim 21 further comprising the step of placing a second retainer member over at least a portion of said second transparent panel.

24. The method of claim 21, wherein the step of changing the configuration of said flexible clip member comprises at least one of extending and compressing said flexible clip member.

25. The method of claim 24, wherein the step of changing the configuration of said flexible clip member comprises abutting a surface against said flexible clip member.

26. The method of claim 23, wherein the step of changing the configuration of a flexible clip member to secure said second transparent panel in a position comprises extending a portion of the flexible clip member past a surface of said first retainer member, contacting said portion of the flexible clip member with said second retainer member to compress said portion of the flexible clip member, and uncompressing said portion of said flexible clip member.

27. The method of claim 26 wherein said second retainer member is curved.

28. The method of claim 21 further comprising the step of at least one of compressing and expanding a portion of said flexible clip member to unsecure said second transparent panel from said position.

29. The method of claim 28 wherein the step of at least one of compressing and expanding said portion of said flexible clip member comprises a tool contacting a surface of said flexible clip member.

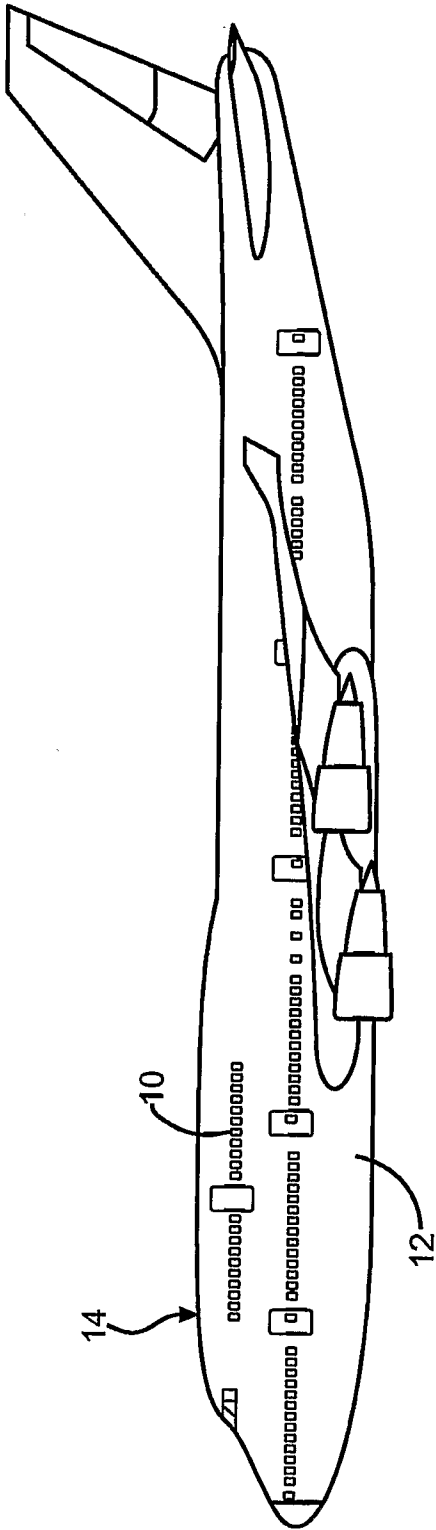


FIG. 1

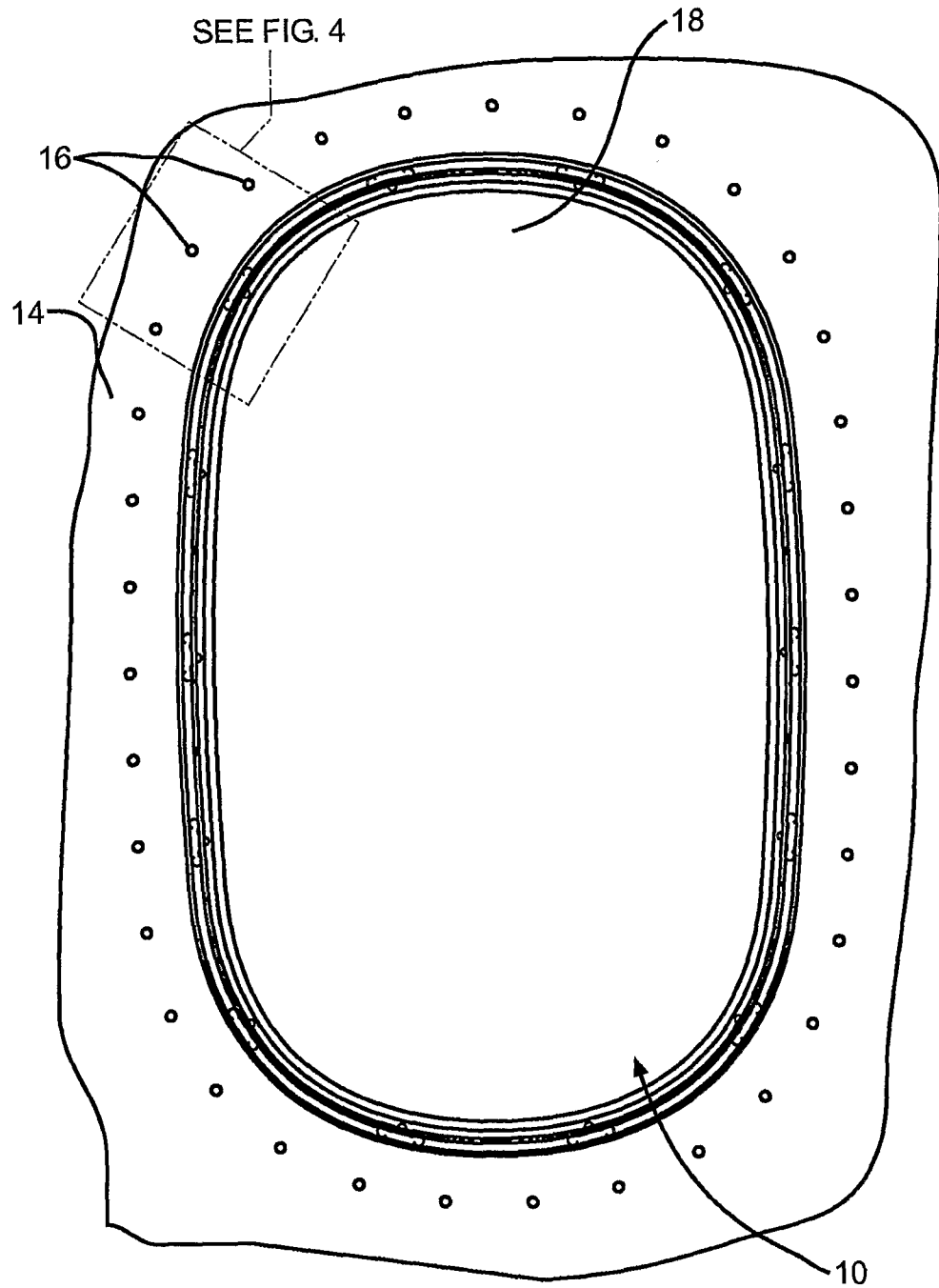


FIG. 2

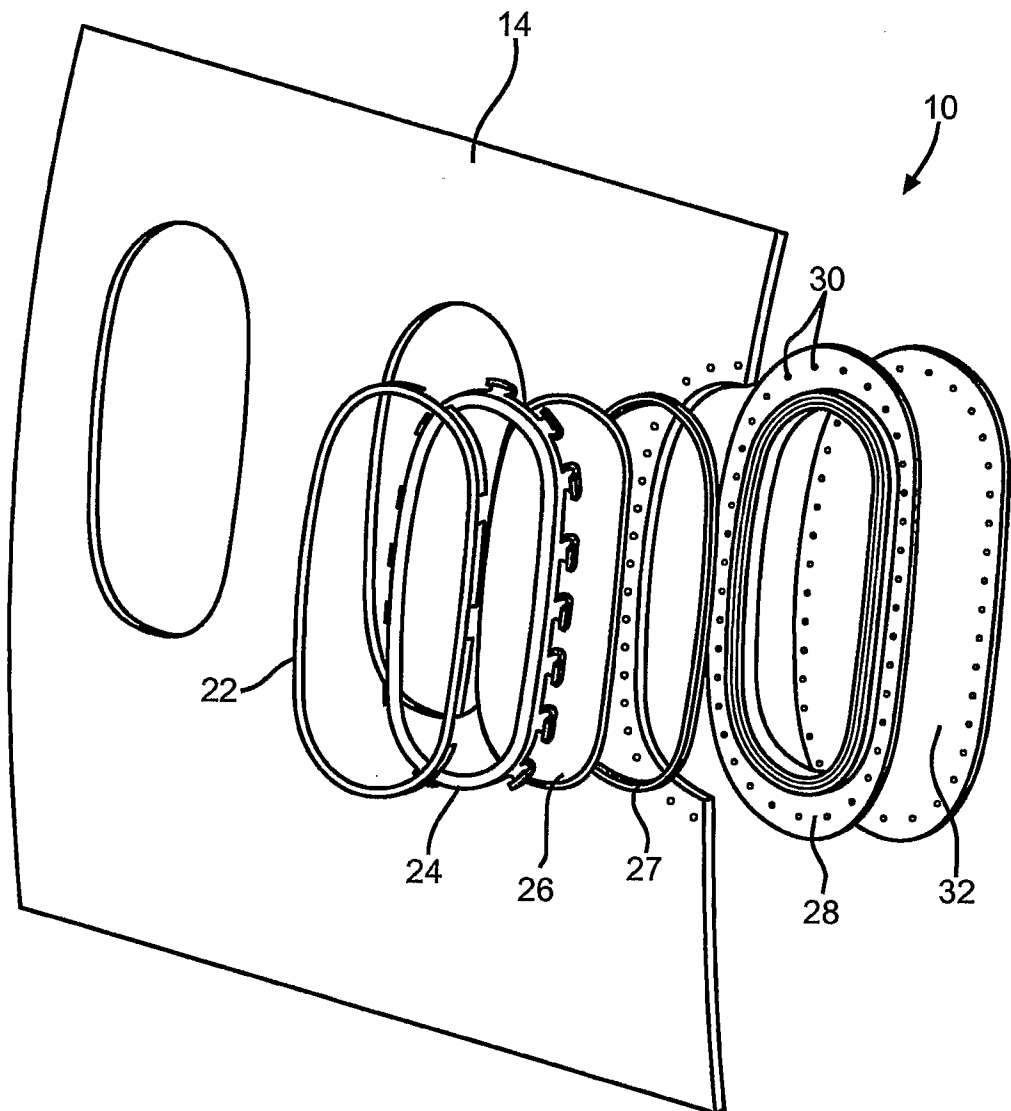


FIG. 3

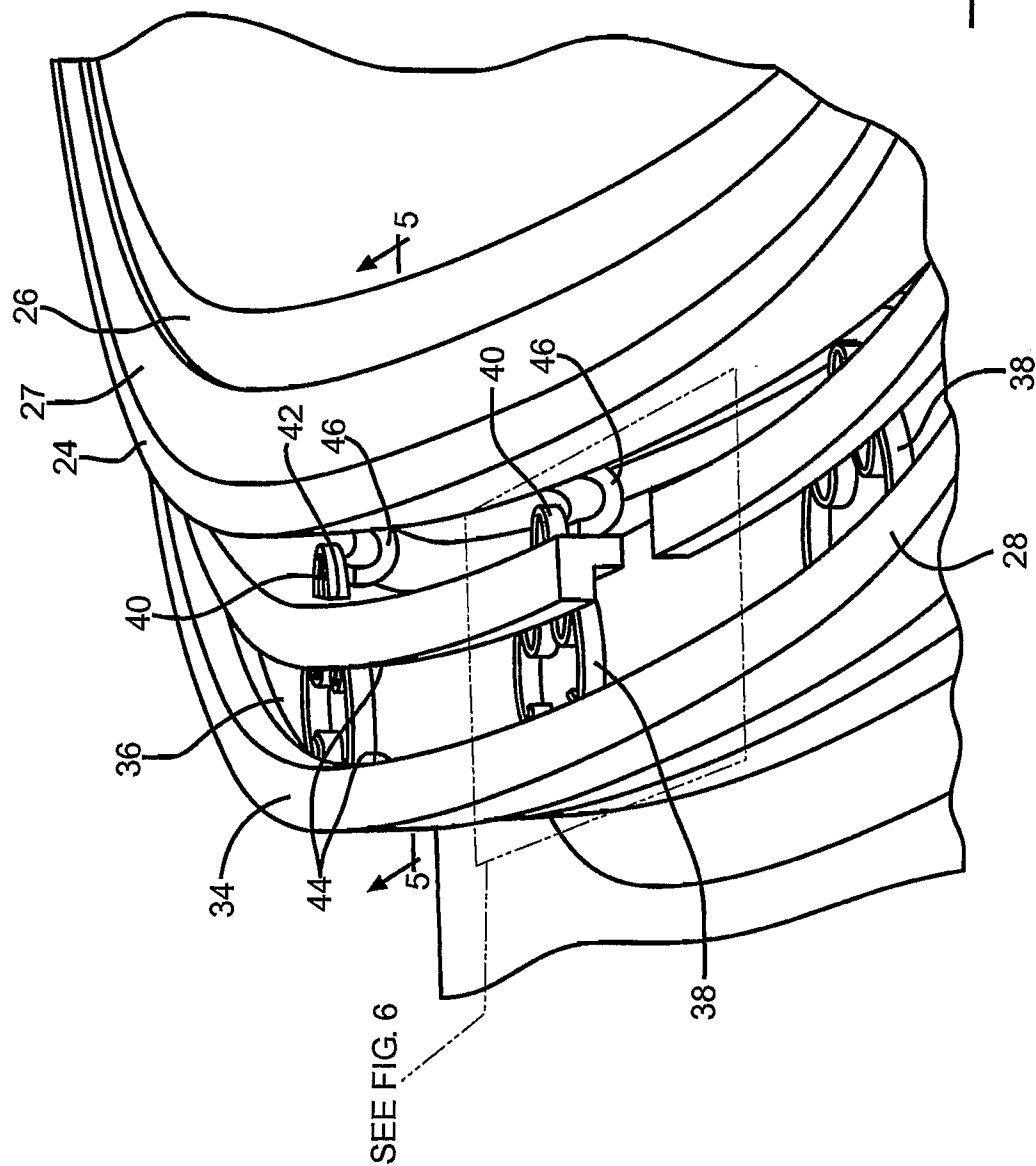
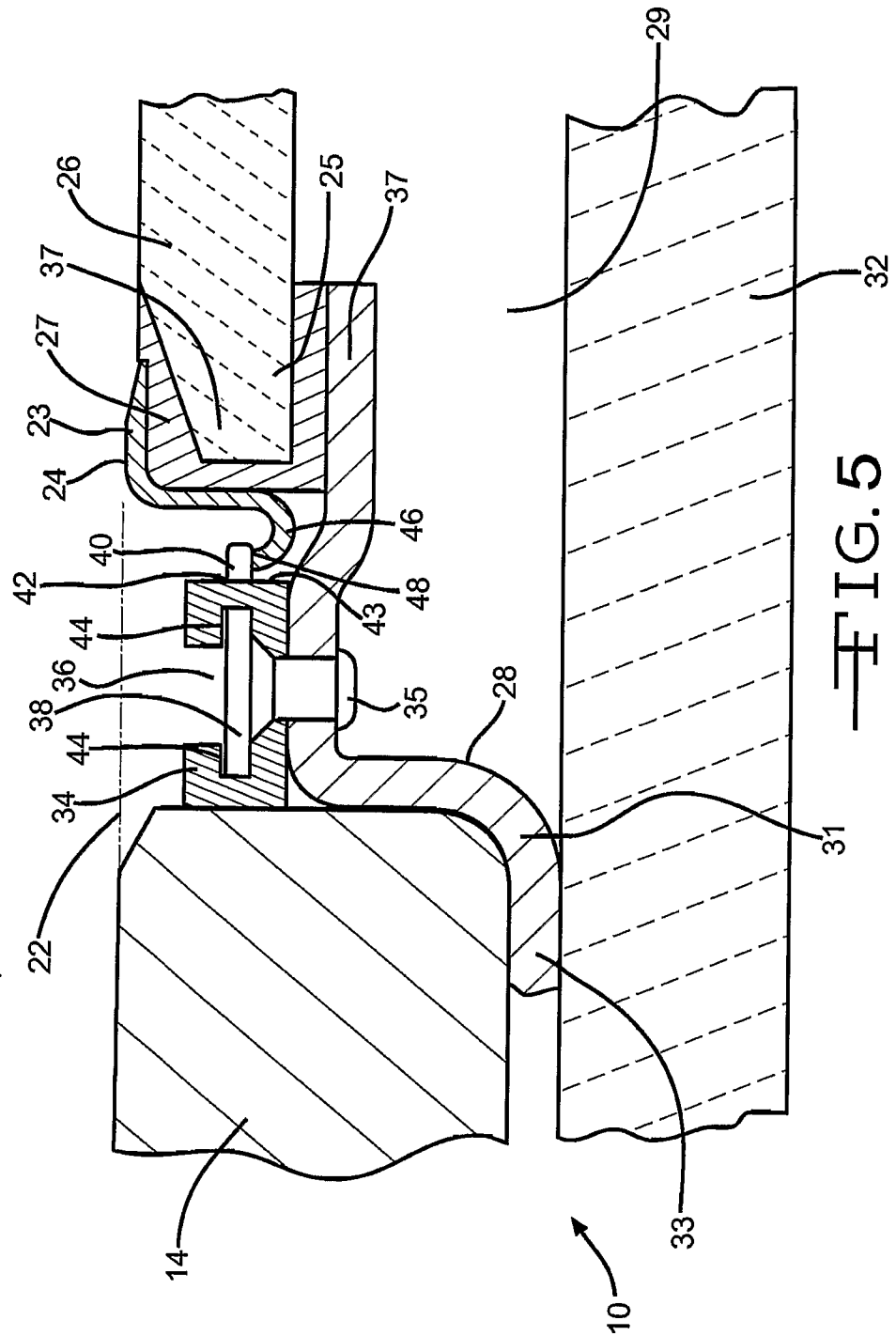


FIG. 4



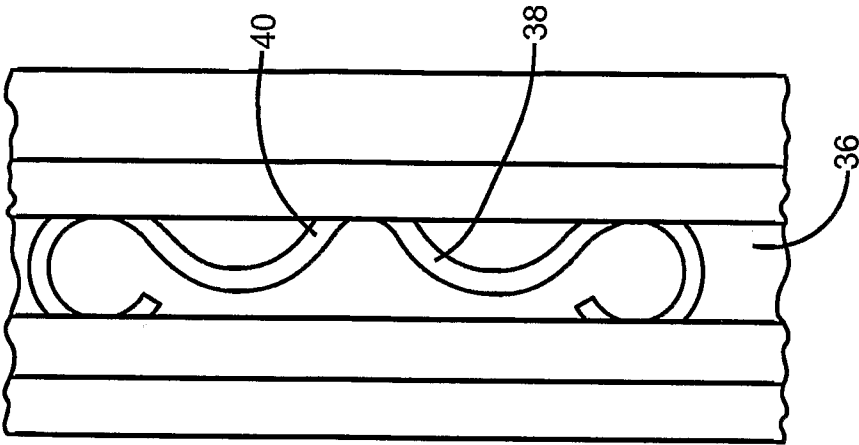


FIG. 7

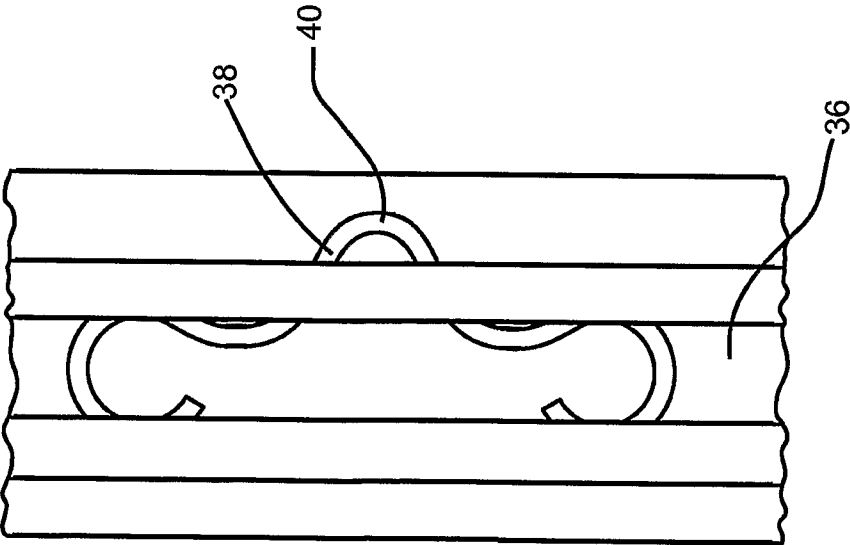


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2006/041829

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C1/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B64C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	EP 1 478 106 A2 (BOEING CO [US]) 17 November 2004 (2004-11-17) paragraphs [0029] - [0031]; figure 3	1-10, 21-23 11,12, 24-29
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☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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