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(54) **Title**: INTEGRATED NACELLE INLET AND METALLIC FAN CONTAINMENT CASE

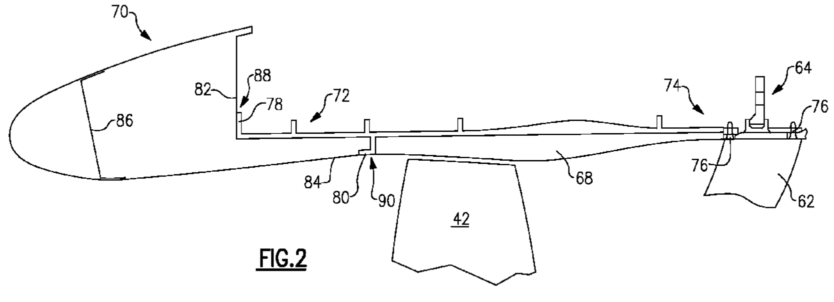

FIG.2

(57) **Abstract**: A fan nacelle includes a metallic fan containment case. A nacelle inlet is secured to the metallic fan containment case by permanent fastening elements. A gas turbine engine includes a metallic fan containment case. A core engine has a static engine structure housing a compressor section, a combustor section and a turbine section. The core engine is configured to receive core airflow. A fan is arranged within the metallic fan containment case. The fan is coupled to the core engine and is arranged in a bypass flowpath provided between the core engine and the metallic fan containment case. A nacelle inlet is secured to the metallic fan containment case by permanent fastening elements.

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INTEGRATED NACELLE INLET AND METALLIC FAN CONTAINMENT CASE

BACKGROUND

[0001] This disclosure relates to an integrated nacelle inlet and metallic fan case.

[0002] One type of gas turbine engine includes a fan driven by a core engine. The fan is arranged in a bypass flowpath, which is provided between the core engine and a fan nacelle. The fan nacelle houses a fan containment case that surrounds the fan. The fan containment case supports structure that provides a seal relative to the fan and retains debris during a fan blade-out event.

[0003] The fan nacelle also includes a fan nacelle inlet arranged upstream from the fan to provide a smooth entry for airflow into the bypass flowpath. Typically, the fan nacelle inlet has been secured to a metallic fan case by removable means, such as nuts and bolts. In one application, a composite fan case has been used, and the nacelle inlet has been integrated with the composite fan case to provide a unitary composite structure.

SUMMARY

[0004] In one exemplary embodiment, a fan nacelle includes a metallic fan containment case. A nacelle inlet is secured to the metallic fan containment case by permanent fastening elements.

[0005] In a further embodiment of any of the above, the nacelle inlet is a metallic structure.

[0006] In a further embodiment of any of the above, the nacelle inlet is a composite structure.

[0007] In a further embodiment of any of the above, the permanent fastening elements is an adhesive.

[0008] In a further embodiment of any of the above, the permanent fastening elements is a weld.

[0009] In a further embodiment of any of the above, the permanent fastening elements is a rivet.

[0010] In a further embodiment of any of the above, the fan containment case supports a rub strip configured to provide a seal relative to a fan.

[0011] In a further embodiment of any of the above, the fan containment case includes first and second flanges. The nacelle inlet includes first and second walls respectively secured to the first and second flanges by the permanent fastening elements.

[0012] In one exemplary embodiment, a gas turbine engine includes a metallic fan containment case. A core engine has a static engine structure housing a compressor section, a combustor section and a turbine section. The core engine is configured to receive core airflow. A fan is arranged within the metallic fan containment case. The fan is coupled to the core engine and is arranged in a bypass flowpath provided between the core engine and the metallic fan containment case. A nacelle inlet is secured to the metallic fan containment case by permanent fastening elements.

[0013] In a further embodiment of any of the above, the nacelle inlet is a metallic structure.

[0014] In a further embodiment of any of the above, the nacelle inlet is a composite structure.

[0015] In a further embodiment of any of the above, the permanent fastening elements is an adhesive.

[0016] In a further embodiment of any of the above, the permanent fastening elements is a weld.

[0017] In a further embodiment of any of the above, the permanent fastening elements is a rivet.

[0018] In a further embodiment of any of the above, the fan containment case supports a rub strip configured to provide a seal relative to a fan.

[0019] In a further embodiment of any of the above, the fan containment case includes first and second flanges. The nacelle inlet includes first and second walls respectively secured to the first and second flanges by the permanent fastening elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The disclosure can be further understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0021] Figure 1 schematically illustrates a gas turbine engine embodiment.

[0022] Figure 2 is an enlarged sectional view of a fan containment case and a nacelle inlet shown in Figure 1.

[0023] Figures 3A and 3B schematically illustrate one permanent connection between the fan containment case and the nacelle inlet.

[0024] Figures 4A and 4B schematically illustrates another permanent connection between the fan containment case and the nacelle inlet.

DETAILED DESCRIPTION

[0025] Figure 1 schematically illustrates an example gas turbine engine 20 that includes a fan section 22, a compressor section 24, a combustor section 26 and a turbine section 28. Alternative engines might include an augmenter section (not shown) among other systems or features. The fan section 22 drives air along a bypass flow path B while the compressor section 24 draws air in along a core flow path C where air is compressed and communicated to a combustor section 26. In the combustor section 26, air is mixed with fuel and ignited to generate a high pressure exhaust gas stream that expands through the turbine section 28 where energy is extracted and utilized to drive the fan section 22 and the compressor section 24.

[0026] Although the disclosed non-limiting embodiment depicts a turbofan gas turbine engine, it should be understood that the concepts described herein are not limited to use with turbofans as the teachings may be applied to other types of turbine engines; for example a turbine engine including a three-spool architecture in which three spools concentrically rotate about a common axis and where a low spool enables a low pressure turbine to drive a fan via a gearbox, an intermediate spool that enables an intermediate pressure turbine to drive a first compressor of the compressor section, and a high spool that enables a high pressure turbine to drive a high pressure compressor of the compressor section.

[0027] The example engine 20 generally includes a low speed spool 30 and a high speed spool 32 mounted for rotation about an engine central longitudinal axis X relative to an engine static structure 36 via several bearing systems 38. It should be understood that various bearing systems 38 at various locations may alternatively or additionally be provided.

[0028] The low speed spool 30 generally includes an inner shaft 40 that connects a fan 42 and a low pressure (or first) compressor section 44 to a low pressure (or first) turbine section 46. The inner shaft 40 drives the fan 42 through a speed change device, such as a geared architecture 48, to drive the fan 42 at a lower speed than the low speed spool 30. The high-speed spool 32 includes an outer shaft 50 that interconnects a high pressure (or second) compressor section 52 and a high pressure (or second) turbine section 54. The inner shaft 40 and the outer shaft 50 are concentric and rotate via the bearing systems 38 about the engine central longitudinal axis X.

[0029] A combustor 56 is arranged between the high pressure compressor 52 and the high pressure turbine 54. In one example, the high pressure turbine 54 includes at least two stages to provide a double stage high pressure turbine 54. In another example, the high pressure turbine 54 includes only a single stage. As used herein, a “high pressure” compressor or turbine experiences a higher pressure than a corresponding “low pressure” compressor or turbine.

[0030] The example low pressure turbine 46 has a pressure ratio that is greater than about 5. The pressure ratio of the example low pressure turbine 46 is measured prior to an inlet of the low pressure turbine 46 as related to the pressure measured at the outlet of the low pressure turbine 46 prior to an exhaust nozzle.

[0031] A mid-turbine frame 57 of the engine static structure 36 is arranged generally between the high pressure turbine 54 and the low pressure turbine 46. The mid-turbine frame 57 further supports bearing systems 38 in the turbine section 28 as well as setting airflow entering the low pressure turbine 46.

[0032] The core airflow C is compressed by the low pressure compressor 44 then by the high pressure compressor 52 mixed with fuel and ignited in the combustor 56 to produce high speed exhaust gases that are then expanded through the high pressure turbine 54 and low pressure turbine 46. The mid-turbine frame 57 includes vanes 59, which are in the core airflow path and function as an inlet guide vane for the low pressure turbine 46. Utilizing the vane 59 of the mid-turbine frame 57 as the inlet guide vane for low pressure turbine 46 decreases the length of the low pressure turbine 46 without increasing the axial length of the mid-turbine frame 57. Reducing or eliminating the number of vanes in the low pressure turbine 46 shortens the axial length of the turbine section 28. Thus, the compactness of the gas turbine engine 20 is increased and a higher power density may be achieved.

[0033] The disclosed gas turbine engine 20 in one example is a high-bypass geared aircraft engine. In a further example, the gas turbine engine 20 includes a bypass ratio greater than about six (6), with an example embodiment being greater than about ten (10). The example geared architecture 48 is an epicyclical gear train, such as a planetary gear system, star gear system or other known gear system, with a gear reduction ratio of greater than about 2.3.

[0034] In one disclosed embodiment, the gas turbine engine 20 includes a bypass ratio greater than about ten (10:1) and the fan diameter is significantly larger than an outer diameter of the low pressure compressor 44. It should be understood, however, that the above parameters are only exemplary of one embodiment of a gas turbine engine including a geared architecture and that the present disclosure is applicable to other gas turbine engines.

[0035] A significant amount of thrust is provided by the bypass flow B due to the high bypass ratio. The fan section 22 of the engine 20 is designed for a particular flight condition -- typically cruise at about 0.8 Mach and about 35,000 feet. The flight condition of 0.8 Mach and 35,000 ft., with the engine at its best fuel consumption - also known as “bucket cruise Thrust Specific Fuel Consumption (‘TSFC’)” - is the industry standard parameter of pound-mass (lbm) of fuel per hour being burned divided by pound-force (lbf) of thrust the engine produces at that minimum point.

[0036] “Low fan pressure ratio” is the pressure ratio across the fan blade alone, without a Fan Exit Guide Vane (“FEGV”) system. The low fan pressure ratio as disclosed herein according to one non-limiting embodiment is less than about 1.50. In another non-limiting embodiment the low fan pressure ratio is less than about 1.45.

[0037] “Low corrected fan tip speed” is the actual fan tip speed in ft/sec divided by an industry standard temperature correction of [(Tram °R) / 518.7) 0.5]. The “Low corrected fan tip speed", as disclosed herein according to one non-limiting embodiment, is less than about 1150 ft/second.

[0038] With continuing reference to Figure 1, the engine 20 includes a fan containment case 60 surrounding the fan section 22. The fan containment case 60 provides a mount 64 configured to attach to a pylon 66 of an aircraft. In the example, the mount 64 is generally axially aligned with the flow exit guide vanes 62. The fan containment case 60 is cylindrical metallic structure constructed from, for example, an aluminum alloy or a nickel alloy. A nacelle inlet 70 is permanently secured to the fan containment case 60 and is arranged upstream from the fan section 22. The nacelle inlet 70 may be constructed from metallic material, such as aluminum, or a composite material, such as a fiber reinforced resin.

[0039] Referring to Figure 2, the fan containment case 60 supports a rub strip 68 arranged adjacent to the tips of the fan blades 42. The rub strip 68 provides a generally close-fitting seal with the fan blades 42 and may be constructed of an abrasion-resistant material. The rub strip 68 typically is constructed from multiple layered components, such as an aluminum honeycomb material and an abrasive-embedded epoxy.

[0040] The fan containment case includes forward and aft ends 72, 74 axially spaced apart from one another. The mount 64 is provided at the aft end 74, which is secured to the flow exit guide vanes 62 via fasteners 76, for example.

[0041] In one example, first and second attachments or flanges 78, 80 are provided at the forward end 72. The nacelle inlet 70 includes first and second walls 82, 84 that are respectively secured to the first and second flanges 78, 80 at first and second joints 88, 90, respectively. The nacelle inlet 70 includes an annular cavity provided between the first and second walls 82, 84. One or more reinforcing members 86 are secured between the first and second walls 82, 84 to maintain the desired contour of the nacelle inlet 70.

[0042] Referring to Figures 3A and 3B, first and second fastening elements 92, 94 are used at the first and second joints 88, 90 to provide a permanent connection at the joints. In this manner, a light, unitary structure may be provided with a metallic fan case without the need of relatively heavy threaded fasteners. "Permanent" means that the fan nacelle inlet and fan containment case are permanently joined to one another at the joint, such that a destructive means must be used to separate the nacelle inlet from the fan containment case. "Destructive means" means that the nacelle inlet, the fan containment case and/or the fastening elements must be plastically deformed or irreparably damaged during removal of the nacelle inlet from the fan containment case.

[0043] Referring to Figure 3A, the first wall 82 is secured to the first flange 78 by the first fastening element 92 at the first joint 88. In one example, the first fastening element is an adhesive or a weld, depending upon the materials of the fan containment case and the nacelle inlet. Referring to Figure 3B, the second wall 84 is secured to the second flange 80 by the second fastening element 94 at the second joint 90. In one example, the second fastening element 94 is an adhesive or a weld.

[0044] Referring to Figures 4A and 4B, the first and second fastening elements 192, 194 may be provided by rivets. The first and second fastening elements 192 provide a permanent connection between the nacelle inlet and the fan containment case. The first wall 182 is secured to the first flange 178 by the first fastening element 192 at the first joint 188. The second wall 184 is secured to the second flange 180 by the second fastening element 194 at the second joint 190.

[0045] Although example embodiments have been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of the claims. For example, permanent fastening elements other than adhesive, welds or rivets may be used. For that reason, the following claims should be studied to determine their true scope and content.

CLAIMS

What is claimed is:

1. A fan nacelle comprising:

a metallic fan containment case; and

a nacelle inlet secured to the metallic fan containment case by permanent fastening elements.

2. The fan nacelle according to claim 1, wherein the nacelle inlet is a metallic structure.

3. The fan nacelle according to claim 1, wherein the nacelle inlet is a composite structure.

4. The fan nacelle according to claim 1, wherein the permanent fastening elements is an adhesive.

5. The fan nacelle according to claim 1, wherein the permanent fastening elements is a weld.

6. The fan nacelle according to claim 1, wherein the permanent fastening elements is a rivet.

7. The fan nacelle according to claim 1, wherein the fan containment case supports a rub strip configured to provide a seal relative to a fan.

8. The fan nacelle according to claim 1, wherein the fan containment case includes first and second flanges, and the nacelle inlet includes first and second walls respectively secured to the first and second flanges by the permanent fastening elements.

9. A gas turbine engine comprising:

a metallic fan containment case;

a core engine having a static engine structure housing a compressor section, a combustor section and a turbine section, the core engine configured to receive core airflow;

a fan arranged within the metallic fan containment case, the fan is coupled to the core engine and is arranged in a bypass flowpath provided between the core engine and the metallic fan containment case; and

a nacelle inlet secured to the metallic fan containment case by permanent fastening elements.

10. The gas turbine engine according to claim 9, wherein the nacelle inlet is a metallic structure.

11. The gas turbine engine according to claim 9, wherein the nacelle inlet is a composite structure.

12. The gas turbine engine according to claim 9, wherein the permanent fastening elements is an adhesive.

13. The gas turbine engine according to claim 9, wherein the permanent fastening elements is a weld.

14. The gas turbine engine according to claim 9, wherein the permanent fastening elements is a rivet.

15. The gas turbine engine according to claim 9, wherein the fan containment case supports a rub strip configured to provide a seal relative to a fan.

16. The gas turbine engine according to claim 9, wherein the fan containment case includes first and second flanges, and the nacelle inlet includes first and second walls respectively secured to the first and second flanges by the permanent fastening elements.

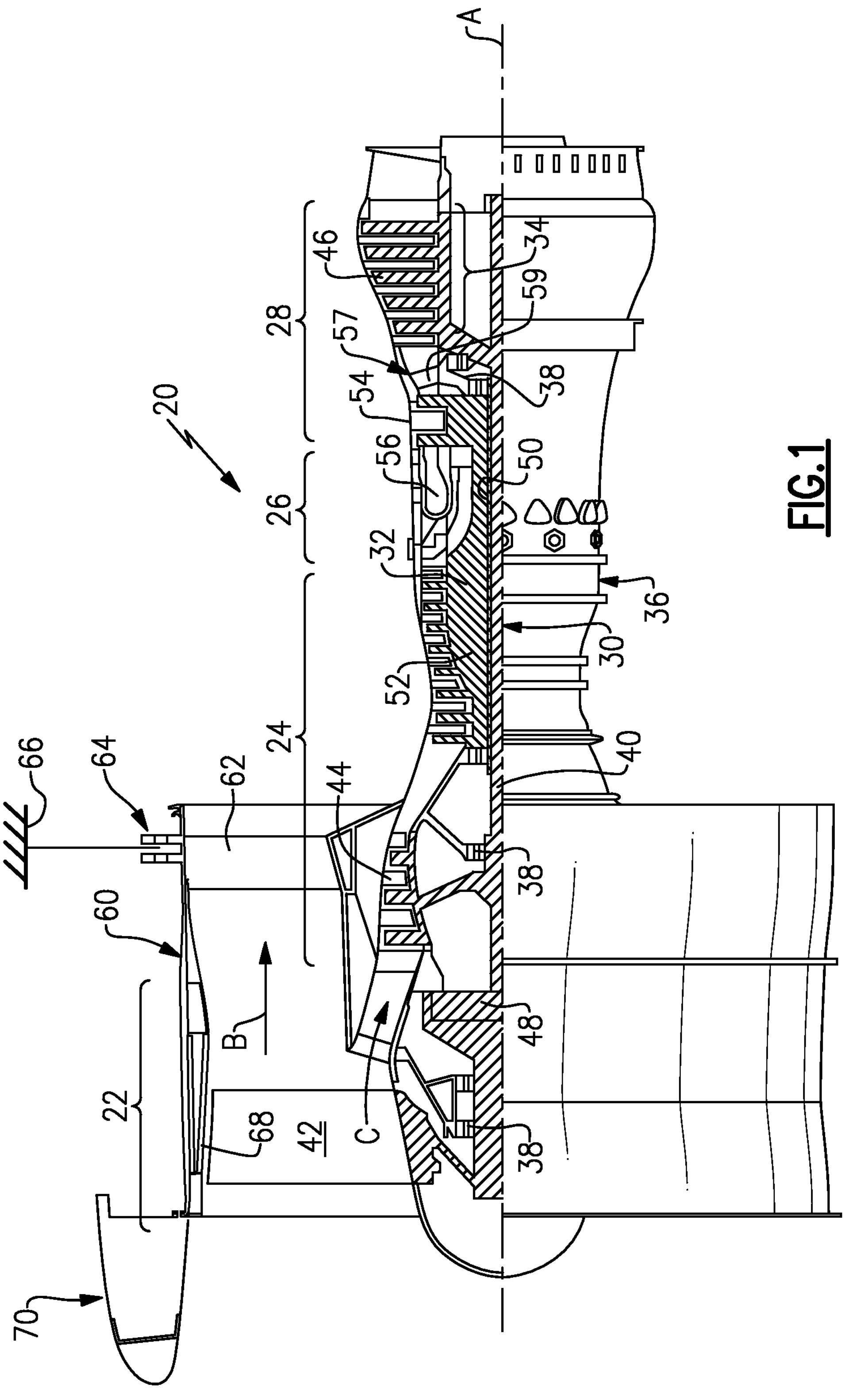
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FIG.1

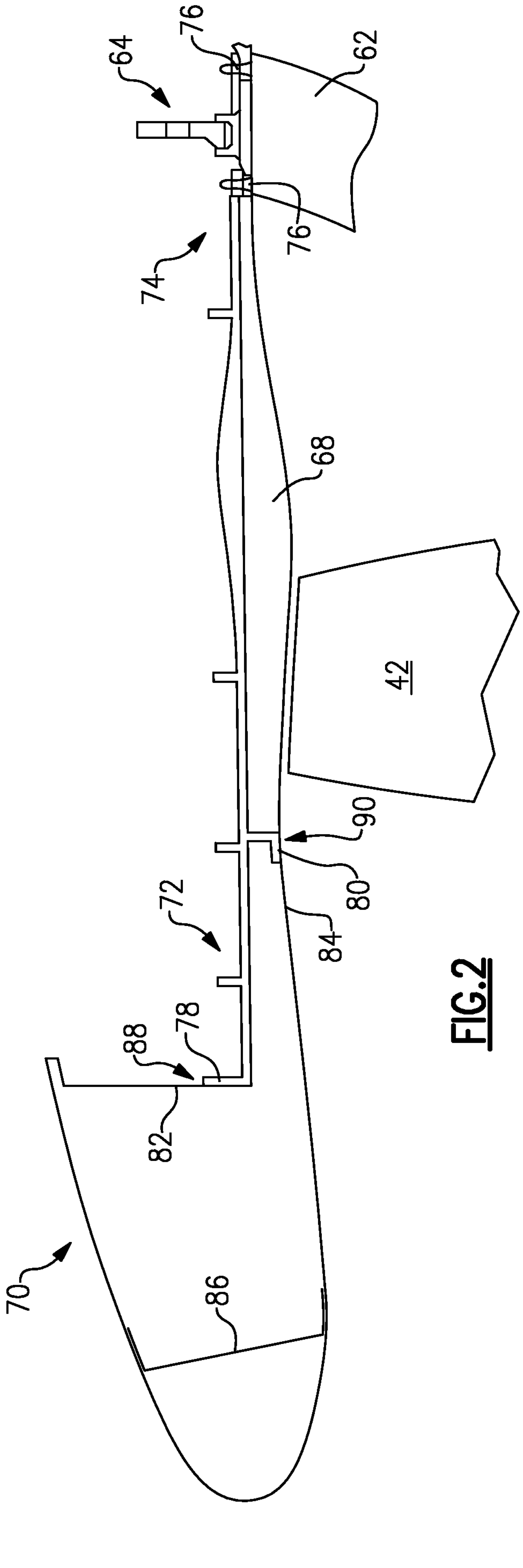

FIG.2

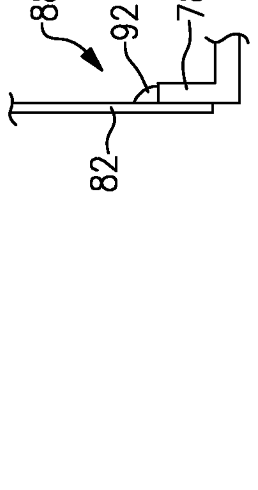

FIG.3A

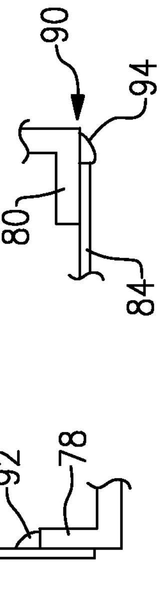

FIG.3B

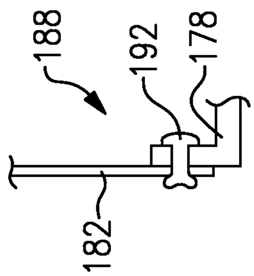

FIG.4A

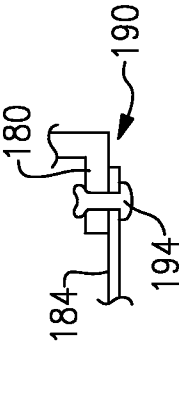

FIG.4B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/046979

A. CLASSIFICATION OF SUBJECT MATTER

F02C 7/00(2006.01)i, F02C 7/04(2006.01)i, F02C 3/00(2006.01)i

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)
F02C 7/00; F02C 7/20; F01D 25/24; F02C 7/32; F04D 29/42; F01D 1/00; B65H 81/02; B64C 39/00; B64C 27/00; F02C 7/04; F02C 3/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: fan containment case, nacelle inlet, fan, and fastening element

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009-0293497 A1 (CLOFT, THOMAS G.) 03 December 2009 See abstract, paragraphs [0016],[0020],[0023], and figures 1,3.	1-16
Y	US 2012-0076647 A1 (ROBERTSON, JR. et al.) 29 March 2012 See abstract, paragraphs [0016]-[0017], and figures 1-3,5.	1-16
Y	US 2011-0052383 A1 (LUSSIER, DARIN S.) 03 March 2011 See abstract, paragraphs [0011]-[0013], and figure 4.	7,15
A	US 8092169 B2 (CLOFT et al.) 10 January 2012 See abstract, column 2, lines 20-40, and figures 2-3.	1-16
A	US 2004-0238687 A1 (JONES et al.) 02 December 2004 See abstract, paragraph [0025], and figure 2.	1-16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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

Date of the actual completion of the international search	Date of mailing of the international search report
17 September 2013 (17.09.2013)	**17 September 2013 (17.09.2013)**

Name and mailing address of the ISA/KR	Authorized officer
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