



(43) International Publication Date  
15 May 2014 (15.05.2014)

(51) International Patent Classification:  
**B64D 27/08** (2006.01)

(21) International Application Number:  
PCT/US2013/031197

(22) International Filing Date:  
14 March 2013 (14.03.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
61/725,099 12 November 2012 (12.11.2012) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: ANGLED CORE GAS TURBINE ENGINE MOUNTING

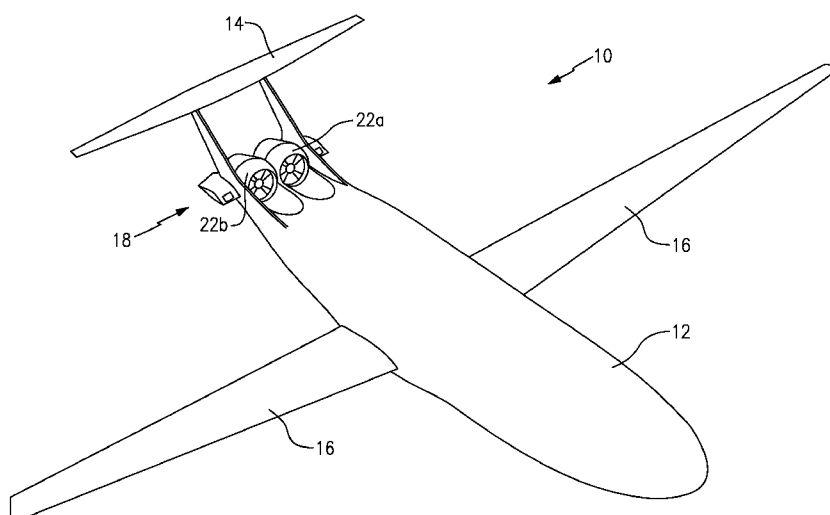


**FIG.1**

(57) Abstract: A propulsion system for an aircraft includes first and second turbine engines mounted within a fuselage of the aircraft. The first turbine engine includes a first engine core that drives a first propulsor disposed about a first propulsor axis. The second turbine engine includes a second engine core and a second propulsor disposed about a second propulsor axis parallel to the first propulsor axis. The first engine core and the second engine core are mounted at an angle relative to corresponding ones of the first and second propulsor axes.

## **ANGLED CORE GAS TURBINE ENGINE MOUNTING**

### **CROSS REFERENCE TO RELATED APPLICATION**

**[0001]** This application claims priority to United States Provisional Application No. 61/725,099 filed on November 12, 2012.

### **BACKGROUND**

**[0002]** Conventional aircraft architecture includes wing mounted gas turbine engines. In some aircraft architectures gas turbine engines are mounted atop the fuselage or on opposite sides of the aircraft fuselage.

**[0003]** Commercial aircraft typically utilize gas turbine engines that include a fan section driven by an engine core or gas generator. The engine core includes a compressor section, a combustor section and a turbine section. Air entering the compressor section is compressed and delivered into the combustion section where it is mixed with fuel and ignited to generate a high-speed exhaust gas flow. The high-speed exhaust gas flow expands through the turbine section to drive the compressor and the fan section through a driven shaft.

**[0004]** Alternate aircraft architectures may require alternate mounting locations of the gas turbine engines to enable specific wing and fuselage configurations. However, conventional gas turbine engine configurations have been developed to operate with conventional aircraft architectures.

**[0005]** Accordingly, alternate gas turbine engine configurations may be required and developed to enable implementation of favorable aspects of alternate engine architectures.

### **SUMMARY**

**[0006]** A propulsion system for an aircraft according to an exemplary embodiment of this disclosure, among other possible things includes a first turbine engine including a first engine core that drives a first propulsor. The first propulsor is disposed about a first propulsor axis and the first engine core is disposed about a first core axis that is skewed from the first propulsor axis. A second turbine engine includes a second engine core that drives a second propulsor. The second propulsor is disposed about a second propulsor

axis parallel to the first propulsor axis. The second engine core is disposed about a second core axis that is skewed from the one or both of the first propulsor axis and the second core axis.

**[0007]** In a further embodiment of the foregoing aircraft, the first core axis and the second core axis are angled away from each other.

**[0008]** In a further embodiment of any of the foregoing aircrafts, the first core axis is disposed at an angle greater than ninety (90) degrees relative to the second core axis.

**[0009]** In a further embodiment of any of the foregoing aircrafts, the first core axis and second engine axis are disposed at an angle greater than about thirty (30) degrees relative to the corresponding first and second propulsor axes.

**[0010]** In a further embodiment of any of the foregoing aircrafts, a burst zone is defined about each of the first and second engine cores.

**[0011]** In a further embodiment of any of the foregoing aircrafts, each of the first and second engine cores is disposed outside of a burst zone defined about the other of the first and second engine cores.

**[0012]** In a further embodiment of any of the foregoing aircrafts, the burst zone is defined as burst angle relative to a line extending perpendicular to each end of the corresponding first and second engine core.

**[0013]** In a further embodiment of any of the foregoing aircrafts, the burst angle is at least about +/- fifteen (15) degrees.

**[0014]** In a further embodiment of any of the foregoing aircrafts, the first and second engine cores include a reverse flow gas turbine engine.

**[0015]** An aircraft according to an exemplary embodiment of this disclosure, among other possible things includes a fuselage, and a first turbine engine including a first engine core that drives a first propulsor. The first propulsor is disposed about a first propulsor axis. A second turbine engine includes a second engine core and a second propulsor. The second propulsor is disposed about a second propulsor axis parallel to the first propulsor axis. The first engine core and the second engine core are mounted at an angle relative a corresponding one of the first and second propulsor axes.

**[0016]** In a further embodiment of the foregoing aircraft, the first engine core is disposed about a first engine axis and the second engine core is disposed about a second

engine axis. The first engine axis and the second engine axis are angled away from each other.

**[0017]** In a further embodiment of any of the foregoing aircrafts, the first engine axis is disposed at an angle greater than ninety (90) degrees relative to the second engine axis.

**[0018]** In a further embodiment of any of the foregoing aircrafts, the first engine axis and second engine axis are disposed at an angle greater than about thirty (30) degrees relative to the corresponding first and second propulsor axes.

**[0019]** In a further embodiment of any of the foregoing aircrafts, a burst zone is defined about each of the first and second engine cores.

**[0020]** In a further embodiment of any of the foregoing aircrafts, each of the first and second engine cores is disposed outside of a burst zone defined about the other of the first and second engine cores.

**[0021]** In a further embodiment of any of the foregoing aircrafts, the burst zone is defined as burst angle relative to a line extending perpendicular to each end of the corresponding first and second engine core.

**[0022]** In a further embodiment of any of the foregoing aircrafts, the burst angle is at least about +/- fifteen (15) degrees.

**[0023]** In a further embodiment of any of the foregoing aircrafts, the first and second engine cores include a reverse flow gas turbine engine.

**[0024]** Although the different examples have the specific components shown in the illustrations, embodiments of this disclosure are not limited to those particular combinations. It is possible to use some of the components or features from one of the examples in combination with features or components from another one of the examples.

**[0025]** These and other features disclosed herein can be best understood from the following specification and drawings, the following of which is a brief description.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0026]** Figure 1 is a schematic view of an aircraft including a propulsion system mounted within the fuselage.

**[0027]** Figure 2 is a schematic view of the example propulsion system.

**[0028]** Figure 3 is a schematic view of a burst zone defined about the example propulsion system.

### DETAILED DESCRIPTION

**[0001]** Referring to the Figures 1 and 2 an aircraft 10 includes a fuselage 12 having wings 16 and a tail 14. A propulsion system 18 is mounted aft end of the fuselage 12. The propulsion system 18 includes first and second engine cores 20a-b, which are reverse core gas turbine engines that drive corresponding first and second propulsors that include respective fan sections 22a-b. The first and second fan sections 22a-b provide the propulsive thrust of the disclosed propulsion system.

**[0002]** Each of the fan sections 22a-b are disposed about corresponding first and second propulsor axis A1 and A2. The first and second engine cores 20a-b is disposed about a corresponding first and second engine axes B1 and B2. That is the first engine core 20a is disposed about the first engine axis B1 and drives the first propulsor about the first propulsor axis A1. The second engine core 20b is disposed about the second engine axis B2 and drives the second fan section 20b about the second propulsor axis A2.

**[0003]** The illustrated reverse engine cores 20a-b are gas generators that include a compressor 24, a combustor 26 and a turbine 28. Air is drawn in through inlets 32a-b to the compressor 24 is compressed and communicated to a combustor 26. In the combustor 26, air is mixed with fuel and ignited to generate an exhaust gas stream that expands through the turbine 28 where energy is extracted and utilized to drive the compressor 24 and corresponding fan 22a-b. In this example the engine cores 20a-b drive the corresponding fan 22a-b through a geared architecture 30a-b.

**[0004]** In the disclosed example, each of the first and second fans 22a-b and related gearing 30a-b is mounted substantially parallel to each other about respective propulsor axes A1, A2. The first and second engine axes B1, B2 are disposed at an angle 34 relative to the corresponding propulsor axis A1, A2. In this example the angle 34 is greater than about thirty (30) degrees. As appreciated other angles are within the contemplation of this disclosure.

**[0005]** Referring to Figure 3, with continued reference to Figure 2, gas turbine engines are not typically mounted next to each other due to practical limitations related to

overall aircraft survivability in the event of engine failure. A burst zone is defined between gas turbine engines within which another gas turbine engine is not permitted due to possible fragmentation from one failed engine disabling the second engine.

**[0006]** The disclosed engine cores 20a-b are disposed at the angle 34 relative to the corresponding propulsor axes A1 and A2 and to each other such that neither engine core 20a-b is disposed within a burst zone 36a-b of the other engine core 20a-b. In other words, each of the engine cores 20a-b is disposed at an angle away from the other engine core 20a-b such that each is orientated outside of the others burst zone 36a-b. In this example, the engine cores 20a-b are angled away from each other at an angle 42 (Figure 2). In this example, the angle 42 is greater than about ninety (90) degrees. As appreciated other angles 42 could be utilized depending on the definition of respective burst zones 36a-b.

**[0007]** The respective burst zones 36a-b is defined as respective annular regions about the corresponding engine core 20a-b. In this example the annular region is disposed at an angle 38 outward from a line 40 perpendicular to the engine axis B1, B2. The example angle is at least fifteen (15) degrees and is determined based on application specific considerations. Moreover, airframe regulations may also define an angular span of the burst zones 36a-b and thereby the angle 38.

**[0008]** The relative orientation between the first and second engine cores 20a-b defines the corresponding burst zones 36a-b that does not interfere with the other engine core 20a-b to comply with application specific survivability requirements.

**[0009]** Accordingly, because the gas generators are mounted in a configuration placing each outside of the others burst zone, fuselage and substantially adjacent mounted propulsors are feasible within desired limitations. The side by side adjacent mounting configuration further enables alternate aircraft architectures.

**[0010]** Although an example embodiment has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this disclosure. For that reason, the following claims should be studied to determine the scope and content of this disclosure.

## CLAIMS

What is claimed is:

1. A propulsion system for an aircraft comprising:  
a first turbine engine including a first engine core that drives a first propulsor, wherein the first propulsor is disposed about a first propulsor axis and the first engine core is disposed about a first core axis that is skewed from the first propulsor axis; and  
a second turbine engine including a second engine core that drives a second propulsor, wherein the second propulsor is disposed about a second propulsor axis parallel to the first propulsor axis, and the second engine core is disposed about a second core axis that is skewed from the one or both of the first propulsor axis and the second core axis.
2. The aircraft as recited in claim 1, wherein the first core axis and the second core axis are angled away from each other.
3. The aircraft as recited in claim 2, wherein the first core axis is disposed at an angle greater than ninety (90) degrees relative to the second core axis.
4. The aircraft as recited in claim 2, wherein the first core axis and second engine axis are disposed at an angle greater than about thirty (30) degrees relative to the corresponding first and second propulsor axes.
5. The aircraft as recited in claim 2, wherein a burst zone is defined about each of the first and second engine cores.
6. The aircraft as recited in claim 5, wherein each of the first and second engine cores is disposed outside of a burst zone defined about the other of the first and second engine cores.
7. The aircraft as recited in claim 5, wherein the burst zone is defined as burst angle relative to a line extending perpendicular to each end of the corresponding first and second engine core.

8. The aircraft as recited in claim 7, wherein the burst angle is at least about +/- fifteen (15) degrees.
9. The aircraft as recited in claim 1, wherein the first and second engine cores comprise a reverse flow gas turbine engine.
10. An aircraft comprising;
  - a fuselage;
  - a first turbine engine including a first engine core that drives a first propulsor, wherein the first propulsor is disposed about a first propulsor axis; and
  - a second turbine engine including a second engine core and a second propulsor, wherein the second propulsor is disposed about a second propulsor axis parallel to the first propulsor axis, and the first engine core and the second engine core are mounted at an angle relative a corresponding one of the first and second propulsor axes.
11. The aircraft as recited in claim 10, wherein the first engine core is disposed about a first engine axis and the second engine core is disposed about a second engine axis, wherein the first engine axis and the second engine axis are angled away from each other.
12. The aircraft as recited in claim 11, wherein the first engine axis is disposed at an angle greater than ninety (90) degrees relative to the second engine axis.
13. The aircraft as recited in claim 11, wherein the first engine axis and second engine axis are disposed at an angle greater than about thirty (30) degrees relative to the corresponding first and second propulsor axes.
14. The aircraft as recited in claim 11, wherein a burst zone is defined about each of the first and second engine cores.

15. The aircraft as recited in claim 14, wherein each of the first and second engine cores is disposed outside of a burst zone defined about the other of the first and second engine cores.
16. The aircraft as recited in claim 14, wherein the burst zone is defined as burst angle relative to a line extending perpendicular to each end of the corresponding first and second engine core.
17. The aircraft as recited in claim 16, wherein the burst angle is at least about +/- fifteen (15) degrees.
18. The aircraft as recited in claim 10, wherein the first and second engine cores comprise a reverse flow gas turbine engine.

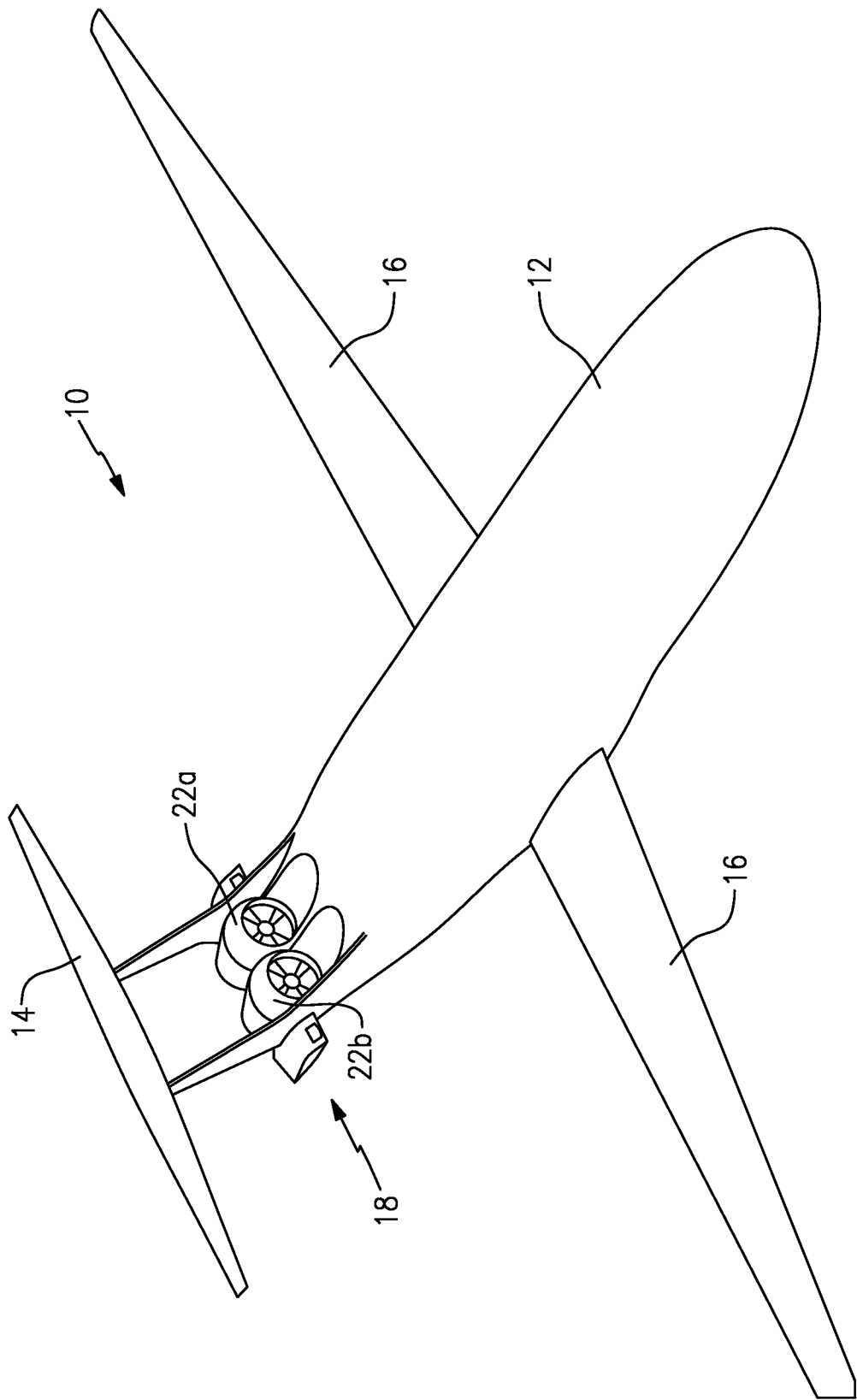


FIG. 1

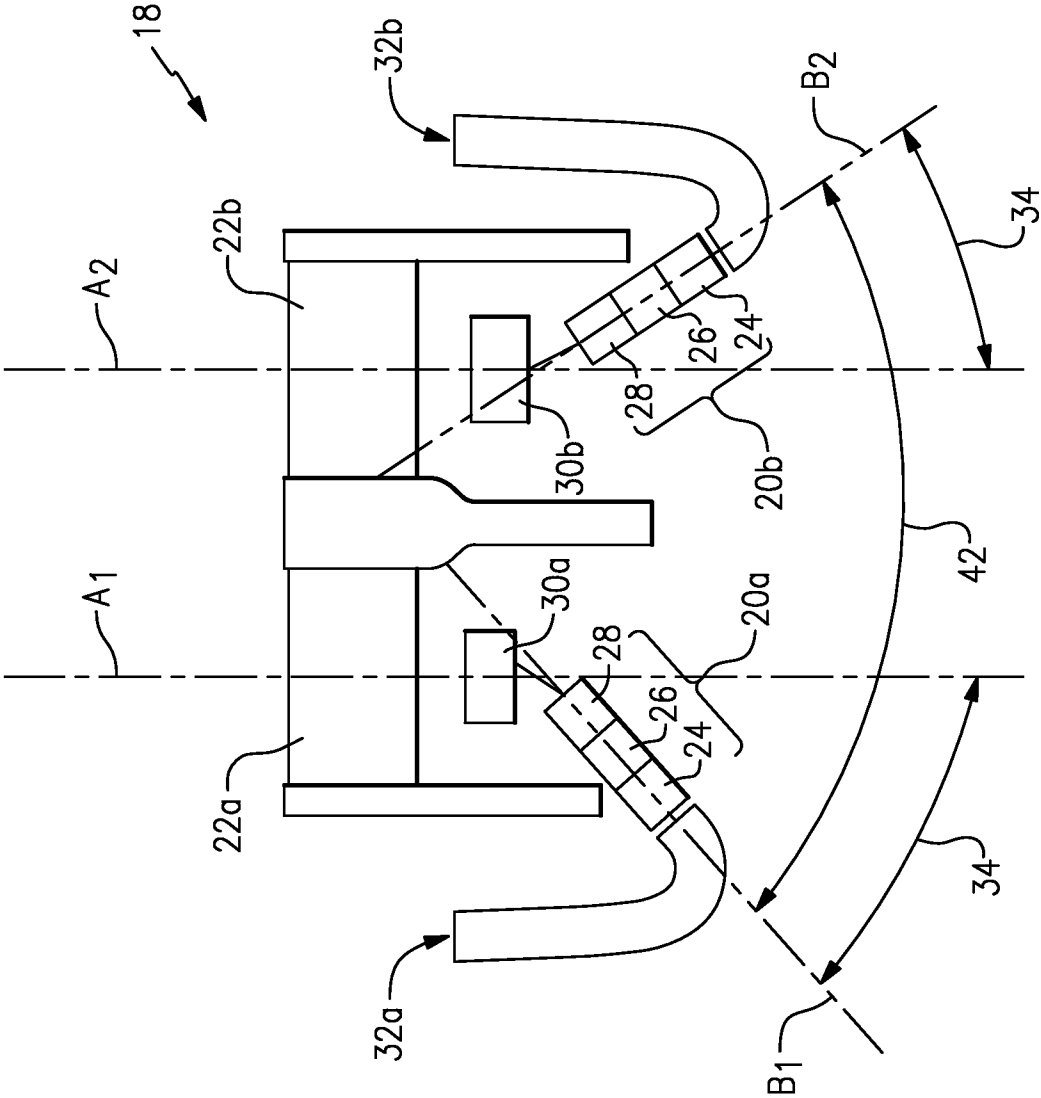


**FIG. 2**

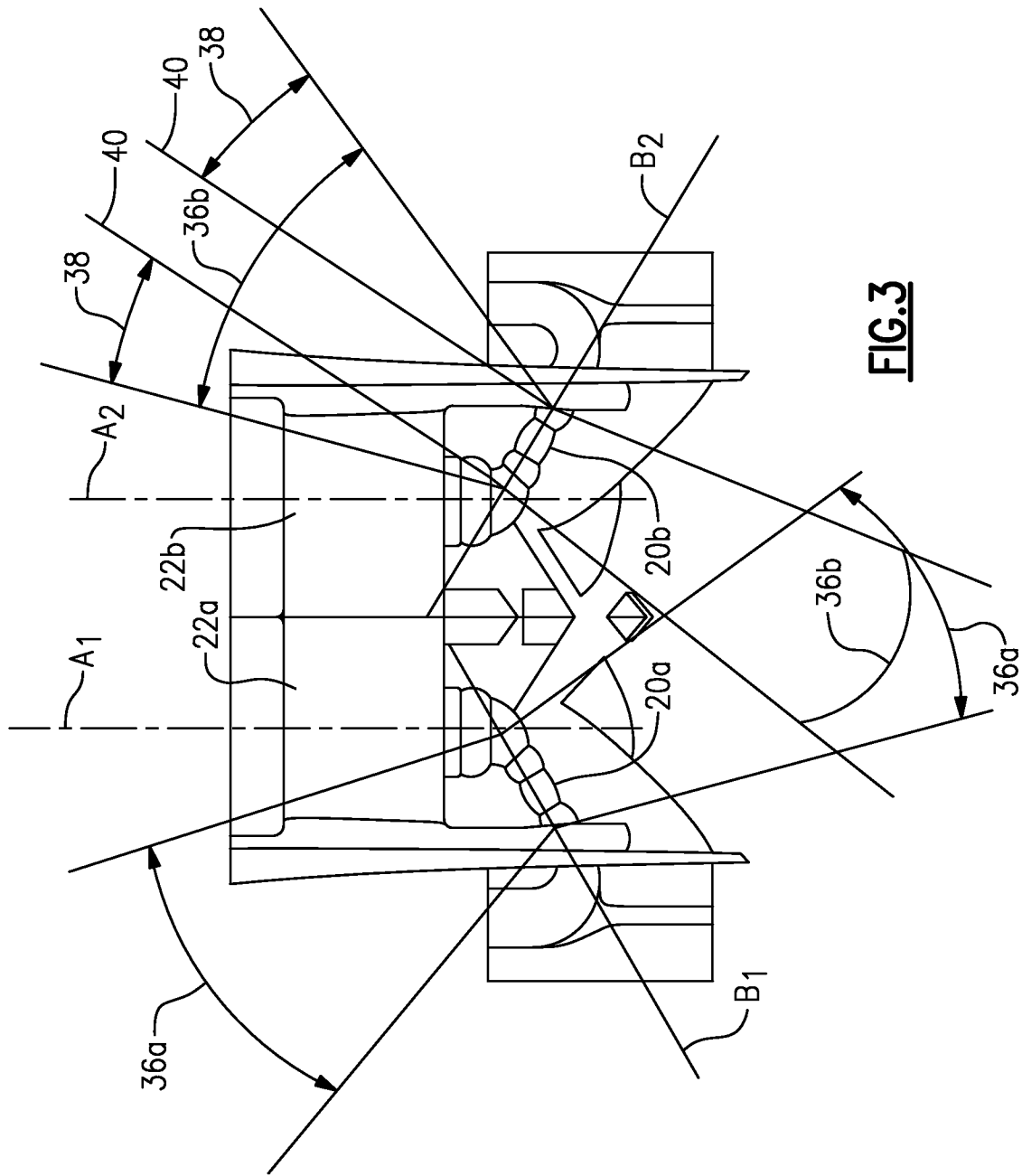


**FIG. 3**

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2013/031197****A. CLASSIFICATION OF SUBJECT MATTER****B64D 27/08(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)

B64D 27/08; B64C 29/00; B64D 27/00; B64D 27/02; B64C 29/04; B64D 29/04; B64C 27/00; B64C 15/14

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) &amp; keywords: aircraft, fuselage, aft portion, propulsion system, turbine engine, propulsor axis, engine core axis, and angle

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                        | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 2010-0155526 A1 (NEGULESCU, DIMITRIE) 24 June 2010<br>See paragraphs [0026]-[0035] and figures 1-4.                    | 1-18                  |
| A         | US 4500055 A (KROJER, HUBERT) 19 February 1985<br>See column 3, lines 15-60, column 5, lines 8-34 and figures 1-2, 12-13. | 1-18                  |
| A         | US 2002-0190158 A1 (FRANCHET et al.) 19 December 2002<br>See paragraphs [0021], [0032] and figures 1-2.                   | 1-18                  |
| A         | US 2001-0011691 A1 (PROVOST, MICHAEL J.) 09 August 2001<br>See paragraphs [0025], [0035]-[0037] and figure 1.             | 1-18                  |
| A         | US 3972490 A (ZIMMERMANN et al.) 03 August 1976<br>See column 4, line 23 - column 5, line 8 and figures 1, 3, 9.          | 1-18                  |



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

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"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

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"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

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

03 December 2013 (03.12.2013)

Date of mailing of the international search report

**04 December 2013 (04.12.2013)**

Name and mailing address of the ISA/KR

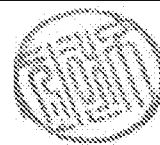
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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2013/031197**

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                                                                   | Publication<br>date                                                                                                                      |
|-------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
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| US 4500055 A                              | 19/02/1985          | JP 58-206495 A                                                                                                                                                               | 01/12/1983                                                                                                                               |
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| US 3972490 A                              | 03/08/1976          | None                                                                                                                                                                         |                                                                                                                                          |