(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 April 2014 (03.04.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/052967 A1

(51) International Patent Classification:
F01D 25/24 (2006.01) *F02K 3/00* (2006.01)
F02C 7/00 (2006.01)

(21) International Application Number:
PCT/US2013/062662

(22) International Filing Date:
30 September 2013 (30.09.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/707,570 28 September 2012 (28.09.2012) US

(71) Applicant: **UNITED TECHNOLOGIES CORPORATION** [US/US]; 1 Financial Plaza, Hartford, Connecticut 06101 (US).

(72) Inventors: **NIGGEMEIER, Chris J.**; 465 Buckland Hills #34412, Manchester, Connecticut 06042 (US). **BLUME, Karl D.**; 148 Joel Drive, Hebron, Connecticut 06248 (US).

(74) Agent: **O'SHEA, Patrick J.**; O'Shea Getz P.C. c/o CPA Global, P.O. Box 52050, Minneapolis, Minnesota 55402 (US).

(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, 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, SA, 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, KM, ML, MR, NE, SN, TD, TG).

Published:

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

(54) **Title**: CASE ASSEMBLY FOR A GAS TURBINE ENGINE

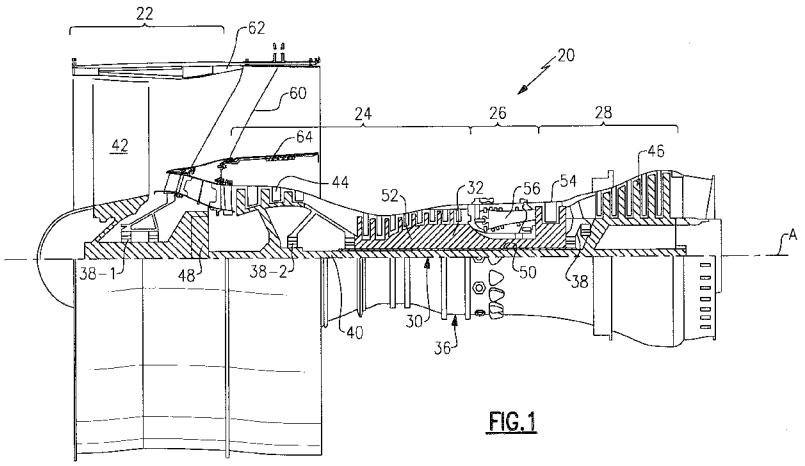

FIG.1

(57) **Abstract**: A case for a gas turbine engine includes an integrated HPC Diffuser case operable to contain a combustor section and a portion of a High Pressure Compressor.

WO 2014/052967 A1

CASE ASSEMBLY FOR A GAS TURBINE ENGINE

Applicant hereby claims priority to U.S. Patent Application No. 61/707,570 filed September 28, 2012, the disclosure of which is herein incorporated by reference.

BACKGROUND

[0001] The present disclosure relates to a gas turbine engine and, more particularly, to a case structure therefor.

[0002] Gas turbine engines, such as those that power modern commercial and military aircraft, generally include a compressor section to pressurize an airflow, a combustor section for burning a hydrocarbon fuel in the presence of the pressurized air, and a turbine section to extract energy from the resultant combustion gases. An engine case structure formed of multiple cases or modules to facilitate assembly surround these sections. Each cases typically abuts another case at a flange. The engine cases are subject to a harsh environment as the products of combustion at high temperature pass therethrough.

SUMMARY

[0003] A case for a gas turbine engine according to one disclosed non-limiting embodiment of the present disclosure includes an integrated High Pressure Compressor Diffuser case operable to contain a combustor section and a portion of a compressor section.

[0004] In a further embodiment of the foregoing embodiment, the integrated HPC Diffuser case is a housing with a reinforced area. In the alternative or additionally thereto, in the foregoing embodiment the reinforced area defines an increased thickness.

[0005] In a further embodiment of any of the foregoing embodiments, the integrated HPC Diffuser case includes a HPC flange to provide a bolted connection with a HPC case.

[0006] In a further embodiment of any of the foregoing embodiments, the integrated HPC Diffuser case includes a HPT flange to provide a bolted connection with a HPT case.

[0007] In a further embodiment of any of the foregoing embodiments, the integrated HPC Diffuser case includes a HPC flange to provide a bolted connection with a HPC case and a HPT flange to provide a bolted connection with a HPT case. In the alternative or additionally thereto, in the foregoing embodiment no flange is located between said HPC flange and said HPT flange. In the alternative or additionally thereto, in the foregoing embodiment a boss arrangement is located between said HPC flange and said HPT flange.

[0008] In a further embodiment of any of the foregoing embodiments, the portion of said compressor section includes two stages.

[0009] In a further embodiment of any of the foregoing embodiments, the portion of said compressor section includes two stages of an eight stage High Pressure Compressor.

[0010] A case assembly of a gas turbine engine according to another disclosed non-limiting embodiment of the present disclosure includes a fan case, an intermediate case boltable to said fan case, a High Pressure Compressor case boltable to said intermediate case, an integrated High Pressure Compressor Diffuser case boltable to said High Pressure Compressor

case, a High Pressure Turbine case boltable to said integrated High Pressure Compressor Diffuser case, a Mid Turbine Frame case boltable to said High Pressure Turbine case, a Low Pressure Turbine case boltable to said Mid Turbine Frame case and a Turbine Exhaust case boltable to said Low Pressure Turbine case.

[0011] In a further embodiment of the foregoing embodiment, the integrated HPC Diffuser case includes a housing with a reinforced area. In the alternative or additionally thereto, in the foregoing embodiment the reinforced area defines an increased thickness.

[0012] In a further embodiment of any of the foregoing embodiments, the integrated HPC Diffuser case includes a HPC flange to provide a bolted connection with a HPC case and a HPT flange to provide a bolted connection with a HPT case. In the alternative or additionally thereto, in the foregoing embodiment a boss arrangement is located between said HPC flange and said HPT flange.

[0013] In a further embodiment of any of the foregoing embodiments, the integrated HPC Diffuser case is operable to contain a combustor section and a portion of a High Pressure Compressor.

[0014] In the alternative or additionally thereto, in the foregoing embodiment the portion of said High Pressure Compressor includes two stages. In the alternative or additionally thereto, in the foregoing embodiment the portion of said High Pressure Compressor includes two stages of an eight stage High Pressure Compressor.

[0015] In a further embodiment of any of the foregoing embodiments, the High Pressure Compressor case is a split case.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Various features will become apparent to those skilled in the art from the following detailed description of the disclosed non-limiting embodiment. The drawings that accompany the detailed description can be briefly described as follows:

[0017] Figure 1 is a schematic cross-section of a gas turbine engine;

[0018] Figure 2 is a schematic view of a gas turbine engine case structure;

[0019] Figure 3 is an expanded perspective view of an integrated HPC Diffuser case;

[0020] Figure 4 is an expanded perspective view of a RELATED ART HPC rear case bolted to a Diffuser case; and

[0021] Figure 5 is an expanded unrolled view of the integrated HPC Diffuser case illustrating a boss arrangement.

DETAILED DESCRIPTION

[0022] Figure 1 schematically illustrates a gas turbine engine 20. The gas turbine engine 20 is disclosed herein as a two-spool turbo fan that generally incorporates a fan section 22, a compressor section 24, a combustor section 26 and a turbine section 28. Alternative engines might include an augmentor section (not shown) among other systems or features. The fan section 22 drives air along a bypass flowpath while the compressor section 24 drives air along a core flowpath for compression and communication into the combustor section 26 then

expansion through the turbine section 28. Although depicted as a turbofan in the disclosed non-limiting embodiment, 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 such as a turbojets, turboshafts, and three-spool (plus fan) turbofans wherein an intermediate spool includes an intermediate pressure compressor ("IPC") between a Low Pressure Compressor ("LPC") and a High Pressure Compressor ("HPC"), and an intermediate pressure turbine ("IPT") between the high pressure turbine ("HPT") and the Low pressure Turbine ("LPT").

[0023] The engine 20 generally includes a low spool 30 and a high spool 32 mounted for rotation about an engine central longitudinal axis A relative to an engine case assembly 36 via several bearing structures 38. The low spool 30 generally includes an inner shaft 40 that interconnects a fan 42, a low pressure compressor 44 ("LPC") and a low pressure turbine 46 ("LPT"). The inner shaft 40 drives the fan 42 directly or through a geared architecture 48 to drive the fan 42 at a lower speed than the low spool 30. An exemplary reduction transmission is an epicyclic transmission, namely a planetary or star gear system.

[0024] The high spool 32 includes an outer shaft 50 that interconnects a high pressure compressor 52 ("HPC") and high pressure turbine 54 ("HPT"). A combustor 56 is arranged between the high pressure compressor 52 and the high pressure turbine 54. The inner shaft 40 and the outer shaft 50 are concentric and rotate about the engine central longitudinal axis A which is collinear with their longitudinal axes.

[0025] Core airflow is compressed by the LPC 44 then the HPC 52, mixed with the fuel and burned in the combustor 56, then expanded over the HPT 54 and the LPT 46. The

turbines 54, 46 rotationally drive the respective low spool 30 and high spool 32 in response to the expansion. The main engine shafts 40, 50 are supported at a plurality of points by bearing structures 38 within the case assembly 36. It should be understood that various bearing structures 38 at various locations may alternatively or additionally be provided.

[0026] In one non-limiting example, the gas turbine engine 20 is a high-bypass geared aircraft engine. In a further example, the gas turbine engine 20 bypass ratio is greater than about six (6:1). The geared architecture 48 can include an epicyclic gear train, such as a planetary gear system or other gear system. The example epicyclic gear train has a gear reduction ratio of greater than about 2.3, and in another example is greater than about 2.5:1. The geared turbofan enables operation of the low spool 30 at higher speeds which can increase the operational efficiency of the low pressure compressor 44 and low pressure turbine 46 and render increased pressure in a fewer number of stages.

[0027] A pressure ratio associated with the low pressure turbine 46 is pressure measured prior to the inlet of the low pressure turbine 46 as related to the pressure at the outlet of the low pressure turbine 46 prior to an exhaust nozzle of the gas turbine engine 20. In one non-limiting embodiment, the bypass ratio of the gas turbine engine 20 is greater than about ten (10:1), the fan diameter is significantly larger than that of the low pressure compressor 44, and the low pressure turbine 46 has a pressure ratio that is greater than about five (5:1). It should be understood, however, that the above parameters are only exemplary of one embodiment of a geared architecture engine and that the present disclosure is applicable to other gas turbine engines including direct drive turbofans.

[0028] In one embodiment, a significant amount of thrust is provided by the bypass flow path B due to the high bypass ratio. The fan section 22 of the gas turbine engine 20 is designed for a particular flight condition - typically cruise at about 0.8 Mach and about 35,000 feet. This flight condition, with the gas turbine engine 20 at its best fuel consumption, is also known as bucket cruise Thrust Specific Fuel Consumption (TSFC). TSFC is an industry standard parameter of fuel consumption per unit of thrust.

[0029] Fan Pressure Ratio is the pressure ratio across a blade of the fan section 22 without the use of a Fan Exit Guide Vane system. The low Fan Pressure Ratio according to one non-limiting embodiment of the example gas turbine engine 20 is less than 1.45. Low Corrected Fan Tip Speed is the actual fan tip speed divided by an industry standard temperature correction of ("T" / $518.7^{0.5}$) in which "T" represents the ambient temperature in degrees Rankine. The Low Corrected Fan Tip Speed according to one non-limiting embodiment of the example gas turbine engine 20 is less than about 1150 fps (351 m/s).

[0030] With reference to Figure 2, the engine case assembly 36 generally includes a multiple of cases or modules to include a fan case 60, an intermediate case 62, a HPC split case 64, an integrated High Pressure Compressor (HPC) diffuser case 66, a High Pressure Turbine (HPT) case 68, a mid turbine frame (MTF) case 70, a Low Pressure Turbine (LPT) case 72, and a Turbine Exhaust case (TEC) 74. The fan case 60 is bolted to the intermediate case 62 which is bolted to the HPC split case 64 which is bolted to the integrated HPC diffuser case 66 which is bolted to the HPT case 68 which is bolted to the mid turbine frame (MTF) case 70 which is bolted to the LPT case 72 which is bolted to the turbine exhaust case (TEC) 74 each at a

respective flange. It should be understood that the order of assembly may not necessarily follow the disclosed description. That is, the cases 60-74 may be assembled or disassembled for maintenance at any interface.

[0031] In one disclosed non-limiting embodiment, the integrated HPC diffuser case 66 is mounted between the split HPC case 64 and the HPT case 68 to surround the last two stages of an eight (8) stage HPC 52 and the combustor 56. That is, the integrated HPC diffuser case 66 contains the combustor 56 and a portion of the HPC 52.

[0032] With reference to Figure 3, the integrated HPC diffuser case 66 generally includes a housing 76 with a reinforced area 78. The reinforced area 78 is a selectively thickened area that provides strength in desired locations as compared with the separate structural arrangement provided by the heretofore utilized separate HPC rear case H and diffuser case D with a flange F therebetween (Figure 4; RELATED ART).

[0033] The integrated HPC diffuser case 66 includes a HPC flange 80 to provide a bolted connection with the HPC split case 64 and a HPT flange 82 to provide a bolted connection with the HPT case 68. The integrated HPC diffuser case 66 provides a shorter overall engine length through elimination of the flange F (Figure 4; RELATED ART) which facilitates a more efficient and compact boss arrangement 84 (Figure 5).

[0034] With reference to Figure 5, a row fuel injector bosses 86 are arranged generally along the middle of the integrated HPC diffuser case 66 between the flanges 80, 82. Environmental Control System (ECS) bosses 88 are telescoped at least partially into the row fuel

injector bosses 86. It should be appreciated that various bosses may additionally or alternatively be provided.

[0035] It should be understood that relative positional terms such as "forward," "aft," "upper," "lower," "above," "below," and the like are with reference to the normal operational attitude of the vehicle and should not be considered otherwise limiting.

[0036] It should be understood that like reference numerals identify corresponding or similar elements throughout the several drawings. It should also be understood that although a particular component arrangement is disclosed in the illustrated embodiment, other arrangements will benefit herefrom.

[0037] Although particular step sequences are shown, described, and claimed, it should be understood that steps may be performed in any order, separated or combined unless otherwise indicated and will still benefit from the present disclosure.

[0038] The foregoing description is exemplary rather than defined by the limitations within. Various non-limiting embodiments are disclosed herein, however, one of ordinary skill in the art would recognize that various modifications and variations in light of the above teachings will fall within the scope of the appended claims. It is therefore to be understood that within the scope of the appended claims, the disclosure may be practiced other than as specifically described. For that reason the appended claims should be studied to determine true scope and content.

CLAIMS

What is claimed is:

1. A case for a gas turbine engine comprising:

an integrated High Pressure Compressor Diffuser case operable to contain a combustor section and a portion of a compressor section.

2. The case as recited in claim 1, wherein said integrated HPC Diffuser case is a housing with a reinforced area.

3. The case as recited in claim 2, wherein said reinforced area defines an increased thickness.

4. The case as recited in claim 1, wherein said integrated HPC Diffuser case includes a HPC flange to provide a bolted connection with a HPC case.

5. The case as recited in claim 1, wherein said integrated HPC Diffuser case includes a HPT flange to provide a bolted connection with a HPT case.

6. The case as recited in claim 1, wherein said integrated HPC Diffuser case includes a HPC flange to provide a bolted connection with a HPC case and a HPT flange to provide a bolted connection with a HPT case.

7. The case as recited in claim 6, wherein no flange is located between said HPC flange and said HPT flange.

8. The case as recited in claim 7, wherein a boss arrangement is located between said HPC flange and said HPT flange.

9. The case as recited in claim 1, wherein said portion of said compressor section includes two stages.

10. The case as recited in claim 1, wherein said portion of said compressor section includes two stages of an eight stage High Pressure Compressor.

11. A case assembly of a gas turbine engine comprising:

a fan case;

an intermediate case boltable to said fan case;

a High Pressure Compressor case boltable to said intermediate case;

an integrated High Pressure Compressor Diffuser case boltable to said High Pressure Compressor case;

a High Pressure Turbine case boltable to said integrated High Pressure Compressor Diffuser case;

a Mid Turbine Frame case boltable to said High Pressure Turbine case;

a Low Pressure Turbine case boltable to said Mid Turbine Frame case; and

a Turbine Exhaust case boltable to said Low Pressure Turbine case.

12. The case assembly as recited in claim 11, wherein said integrated HPC Diffuser case includes a housing with a reinforced area.

13. The case assembly as recited in claim 12, wherein said reinforced area defines an increased thickness.

14. The case assembly as recited in claim 13, wherein said integrated HPC Diffuser case includes a HPC flange to provide a bolted connection with a HPC case and a HPT flange to provide a bolted connection with a HPT case.

15. The case assembly as recited in claim 14, wherein a boss arrangement is located between said HPC flange and said HPT flange.

16. The case assembly as recited in claim 11, wherein said integrated HPC Diffuser case is operable to contain a combustor section and a portion of a High Pressure Compressor.

17. The case assembly as recited in claim 16, wherein said portion of said High Pressure Compressor includes two stages.

18. The case assembly as recited in claim 16, wherein said portion of said High Pressure Compressor includes two stages of an eight stage High Pressure Compressor.

19. The case assembly as recited in claim 11, wherein said High Pressure Compressor case is a split case.

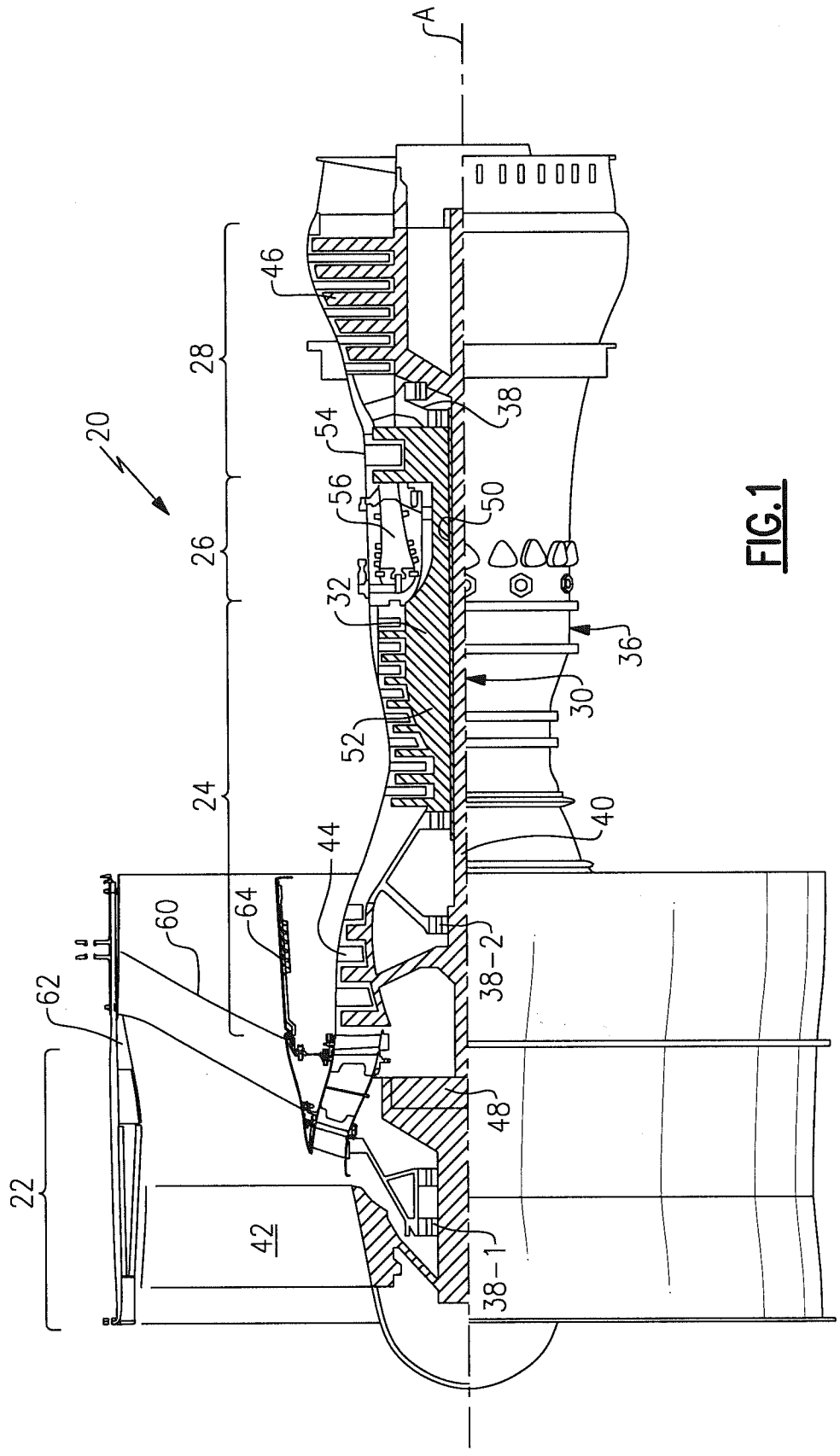

FIG.1

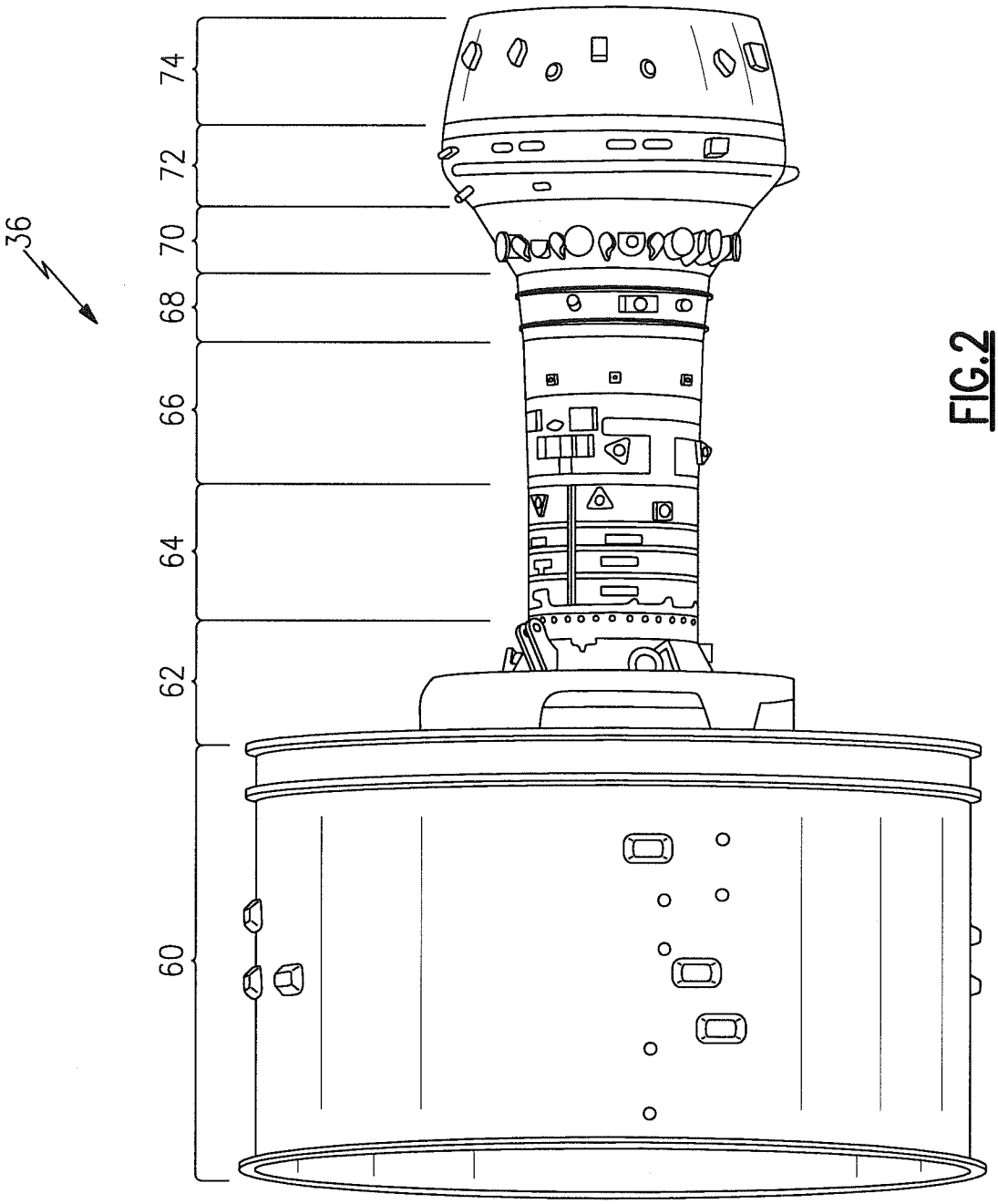

FIG.2

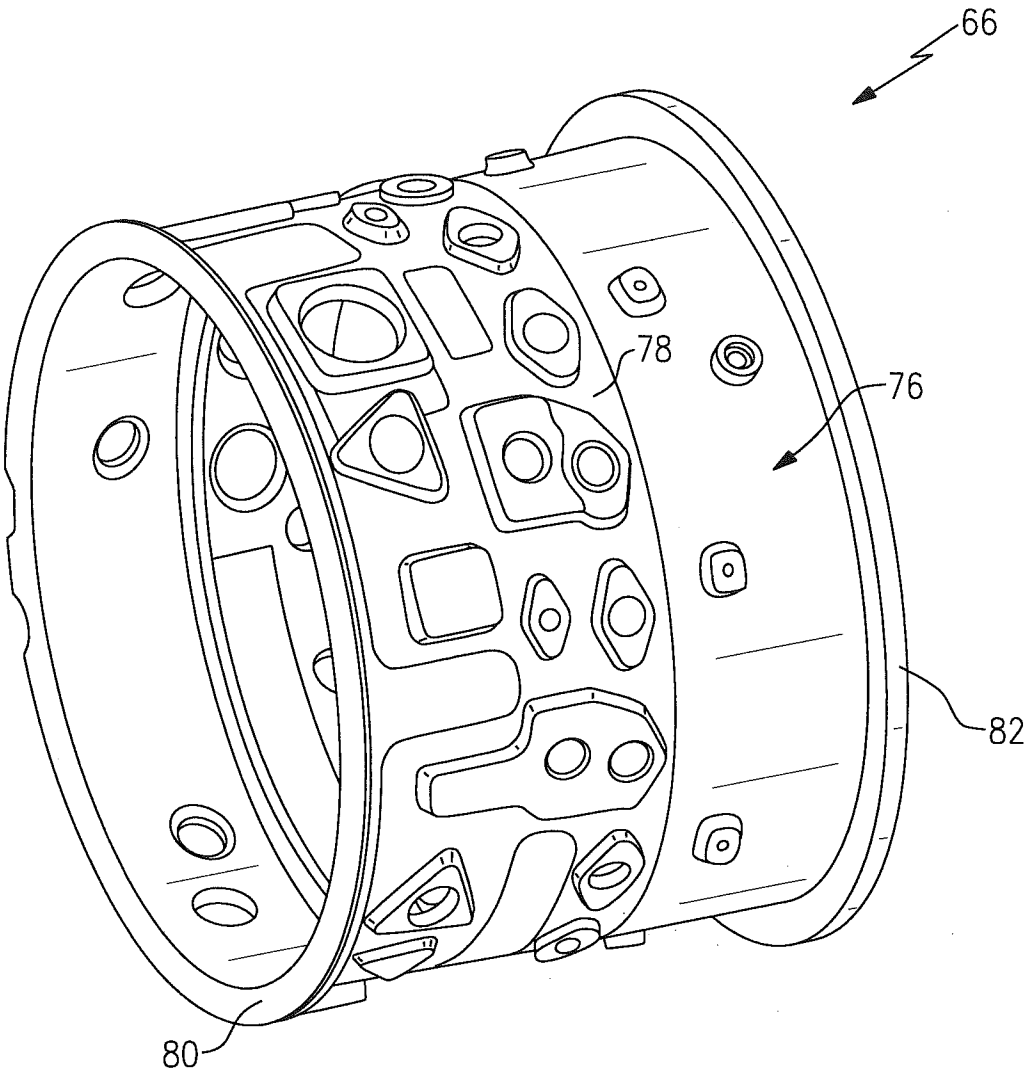

FIG.3

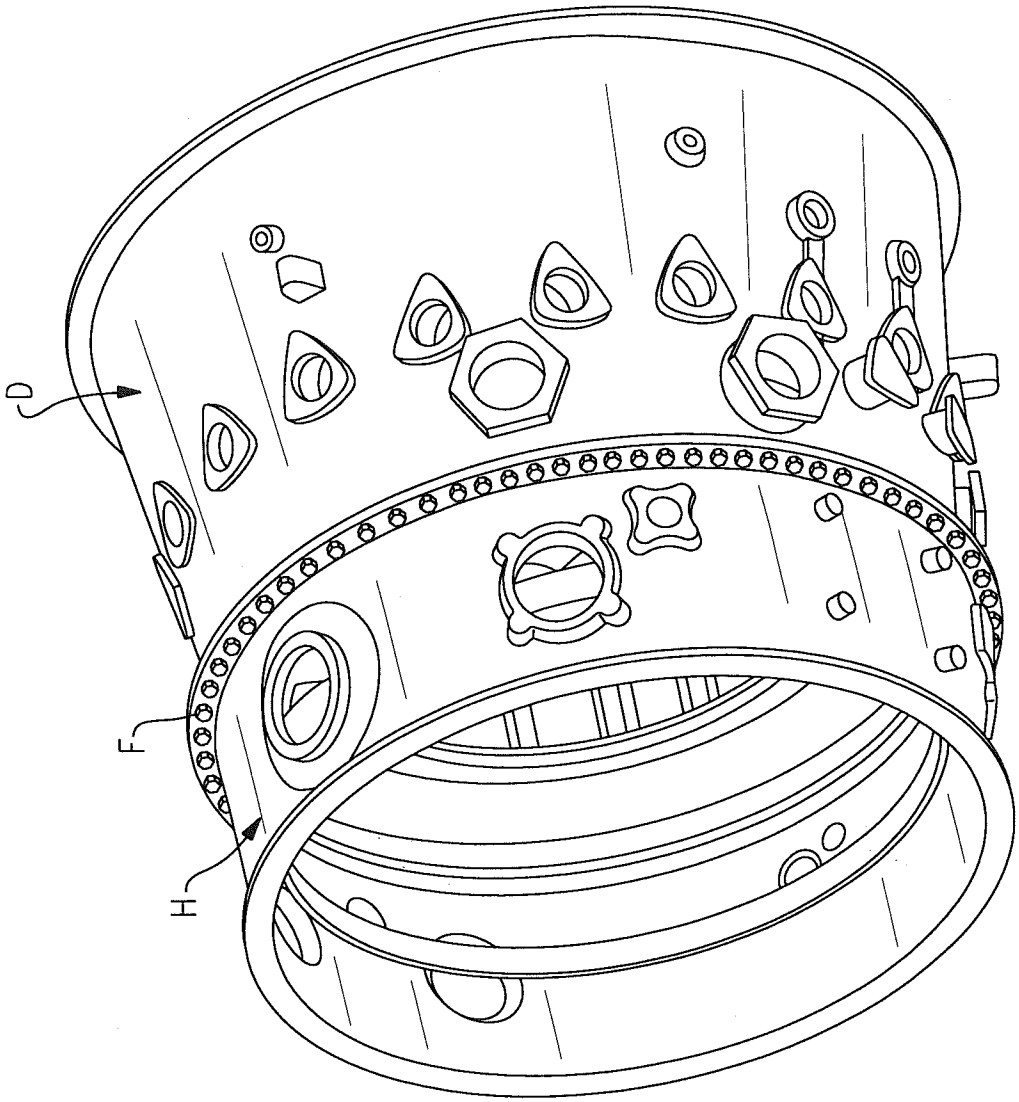

FIG.4
Related Art

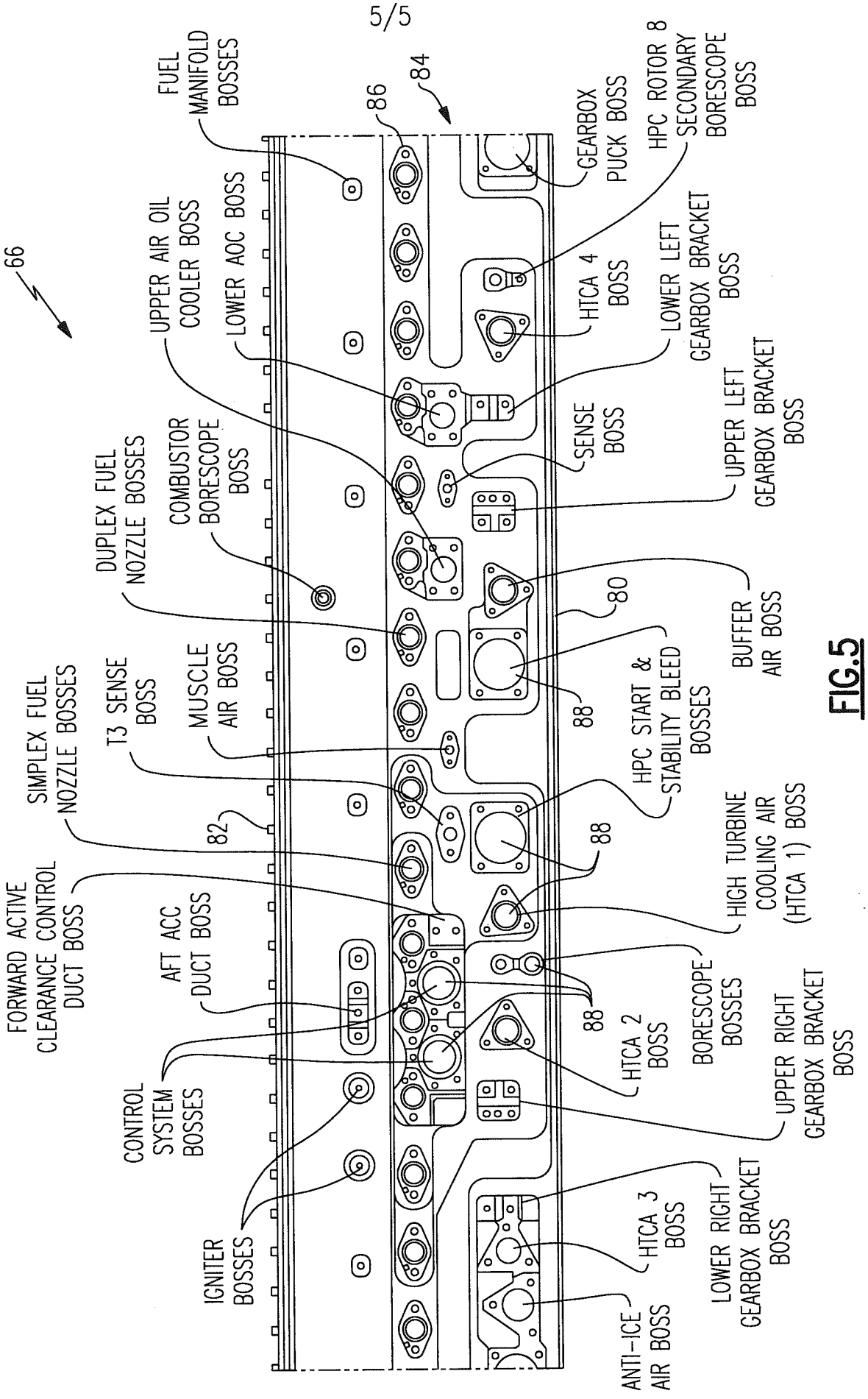
66
FUEL MANIFOLD BOSSES
86
84
GEARBOX PUCK BOSS
HPC ROTOR 8 SECONDARY BORESCOPE BOSS
UPPER AIR OIL COOLER BOSS
LOWER AOC BOSS
HTCA 4 BOSS
LOWER LEFT GEARBOX BRACKET BOSS
DUPLEX FUEL NOZZLE BOSSES
COMBUSTOR BORESCOPE BOSS
SENSE BOSS
UPPER LEFT GEARBOX BRACKET BOSS
80
BUFFER AIR BOSS
SIMPLEX FUEL NOZZLE BOSSES
T3 SENSE BOSS
MUSCLE AIR BOSS
88
HPC START & STABILITY BLEED BOSSES
82
FORWARD ACTIVE CLEARANCE CONTROL DUCT BOSS
AFT ACC DUCT BOSS
HIGH TURBINE COOLING AIR (HTCA 1) BOSS
CONTROL SYSTEM BOSSES
HTCA 2 BOSS
BORESCOPE BOSSES
UPPER RIGHT GEARBOX BRACKET BOSS
IGNITER BOSSES
HTCA 3 BOSS
LOWER RIGHT GEARBOX BRACKET BOSS
ANTI-ICE AIR BOSS

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/062662

A. CLASSIFICATION OF SUBJECT MATTER

F01D 25/24(2006.01)i, F02C 7/00(2006.01)i, F02K 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)
F01D 25/24; F02C 7/20; F01B 25/00; F02C 3/06; F02C 7/00; B21D 31/00; F04D 3/00; F02K 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: turbine, compressor, diffuser, case, casing, housing, reinforce, boss, flange

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012-0167592 A1 (SUCIU et al.) 5 July 2012 See paragraphs [0021]-[0024]; figures 1-2.	1-8,11-16,19
A		9-10,17-18
Y	US 2011-0185699 A1 (DANIS et al.) 4 April 2011 See paragraphs [0019]-[0024]; figures 1-2.	1-8,11-16,19
A		9-10,17-18
Y	US 2008-0078227 A1 (GREEN et al.) 3 April 2008 See paragraphs [0022]-[0026]; figures 1-2.	2-3,8,12-15
A		1,4-7,9-11,16-19
Y	US 2012-0121390 A1 (SUCIU et al.) 17 May 2012 See paragraphs [0042]-[0045]; figures 1B-1C.	11-16,19
A		1-10,17-18
Y	US 2008-0101922 A1 (SCHIRLE et al.) 1 May 2008 See claims 1-3.	19
A		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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another 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
07 January 2014 (07.01.2014)	**08 January 2014 (08.01.2014)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
HAN, Joong Sub
Telephone No. +82-42-481-5606

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/062662

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012-0167592 A1	05/07/2012	EP 2103516 A2	23/09/2009
		EP 2103516 A3	21/11/2012
		US 2009-236469 A1	24/09/2009
		US 8167237 B2	01/05/2012
		US 8328133 B2	11/12/2012
US 2011-0185699 A1	04/08/2011	EP 2354491 A2	10/08/2011
		JP 2011-157963 A	18/08/2011
		US 8387358 B2	05/03/2013
US 2008-0078227 A1	03/04/2008	GB 0619361 D0	08/11/2006
		GB 2442238 A	02/04/2008
		GB 2442238 B	01/10/2008
US 2012-0121390 A1	17/05/2012	US 2009-314881 A1	24/12/2009
		US 2012-099963 A1	26/04/2012
		US 8128021 B2	06/03/2012
		US 8267349 B2	18/09/2012
US 2008-0101922 A1	01/05/2008	CN 101169137 A	30/04/2008
		DE 102007051633 A1	30/04/2008
		JP 2008-111435 A	15/05/2008
		KR 10-2008-0038041 A	02/05/2008