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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 October 2013 (03.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/147975 A1

(51) International Patent Classification:
F02C 6/08 (2006.01)

(21) International Application Number:
PCT/US2013/020746

(22) International Filing Date:
9 January 2013 (09.01.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/362,499 31 January 2012 (31.01.2012) 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))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: BUFFER SYSTEM FOR A GAS TURBINE ENGINE

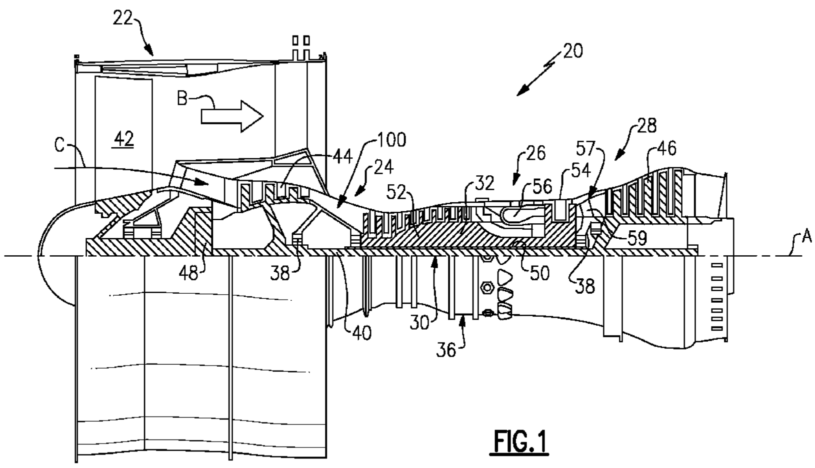

FIG.1

(57) Abstract: A buffer system for a gas turbine engine includes a heat exchanger having a first inlet and outlet and a second inlet and outlet. The first outlet is configured to provide a cooled pressurized fluid. First and second air sources are selectively fluidly coupled to the first inlet. A third air source is fluidly coupled to the second inlet. Multiple fluid-supplied areas are located remotely from one another and are fluidly coupled to the first outlet. The multiple fluid-supplied areas include multiple bearing compartments. A method of providing pressurized air in a gas turbine engine includes selectively providing pressurized air from multiple air sources to a heat exchanger to cool the pressurized air. The cooled pressurized air is distributed to multiple fluid-supplied areas within the gas turbine engine.

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BUFFER SYSTEM FOR A GAS TURBINE ENGINE

BACKGROUND

[0001] This disclosure relates to buffer system for a gas turbine engine.

[0002] Gas turbine engines typically require air from one of the compressor stages to provide buffer air to a bearing compartment, for example. One proposed system utilizes a valve in the buffer system that regulates the fluid flow from a high compressor stage and a low compressor stage. The regulated air is provided to a cooler and a bearing compartment.

[0003] Another system utilizes a dedicated centrifugal compressor to provide pressurized air to multiple bearing compartments and provide shaft ventilation. The centrifugal compressor is a separate compressor, discrete from the high pressure and low pressure compressor stages of the gas turbine engine.

SUMMARY

[0004] A buffer system for a gas turbine engine includes a heat exchanger having a first inlet and outlet and a second inlet and outlet. The first outlet is configured to provide a cooled pressurized fluid. First and second air sources are selectively fluidly coupled to the first inlet. A third air source is fluidly coupled to the second inlet. Multiple fluid-supplied areas are located remotely from one another and fluidly coupled to the first outlet. The multiple fluid-supplied areas include multiple bearing compartments.

[0005] In a further embodiment of the above, the first, second and third air sources are different than one another.

[0006] In a further embodiment of any of the above, low and high pressure compressors are included. One the first and second air sources is provided by the high pressure compressor, and the third air source is provided by the low pressure compressor.

[0007] In a further embodiment of any of the above, a valve is fluidly coupled to at least one of the first and second air sources. The valve is configured to regulate fluid flow from the first and second air sources to the heat exchanger.

[0008] In a further embodiment of any of the above, a mid-stage is provided fluidly between the low and high pressure compressors. The other of the first and second air sources is provided by the mid-stage.

[0009] In a further embodiment of any of the above, a high pressure compressor includes a rotor, and the multiple fluid-supplied areas include the rotor.

[0010] In a further embodiment of any of the above, a low pressure turbine includes a shaft, and the multiple fluid-supplied areas include the shaft.

[0011] In a further embodiment of any of the above, the multiple fluid-supplied areas include a component, which is configured to be cooled by the cooled pressurized fluid.

[0012] In a further embodiment of any of the above, a bypass flow path is arranged between core and fan nacelles, and the second outlet is fluidly coupled to the bypass flow path.

[0013] In a further embodiment of any of the above, a low pressure compressor is fluidly coupled to the second inlet.

[0014] A method of providing pressurized air in a gas turbine engine includes selectively providing pressurized air from multiple air sources to a heat exchanger to cool the pressurized air. The cooled pressurized air is distributed to multiple fluid-supplied areas within the gas turbine engine.

[0015] In a further embodiment of any of the above, the selectively providing step includes regulating air from first and second air sources that have different pressures.

[0016] In a further embodiment of any of the above, the method includes the step of cooling the pressurized air by providing low pressure compressor air to the heat exchanger.

[0017] In a further embodiment of any of the above, the distributing step includes providing the cooled pressurized air to multiple bearing compartments.

[0018] In a further embodiment of any of the above, the distributing step includes providing the cooled pressurized air to at least one of a high pressure compressor rotor, a low pressure turbine shaft, and a component.

[0019] In another embodiment, a gas turbine engine includes a fan and a compressor section fluidly connected to the fan. A combustor is fluidly connected to the compressor section, and a turbine section is fluidly connected to the combustor. A buffer system includes a heat exchanger having a first inlet and outlet and a second inlet and outlet. The first outlet is configured to provide a cooled pressurized fluid. First and second air sources are selectively fluidly coupled to the first inlet. A third air source is fluidly coupled to the second inlet. Multiple fluid-supplied areas are located remotely from one another and are fluidly coupled to the first outlet. The multiple fluid-supplied areas include multiple bearing compartments.

[0020] In a further embodiment of any of the above, the gas turbine engine is a high bypass geared aircraft engine having a bypass ratio of greater than about six (6).

[0021] In a further embodiment of any of the above, the gas turbine engine includes a low Fan Pressure Ratio of less than about 1.45.

[0022] In a further embodiment of any of the above, the low pressure turbine has a pressure ratio that is greater than about 5.

[0023] In a further embodiment of the above, the first, second and third air sources are different than one another.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The disclosure can be further understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0025] Figure 1 schematically illustrates a gas turbine engine.

[0026] Figure 2 is a schematic of an example buffer system for a gas turbine engine.

DETAILED DESCRIPTION

[0027] Figure 1 schematically illustrates a gas turbine engine 20. The gas turbine engine 20 is disclosed herein as a two-spool turbofan 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 B while the compressor section 24 drives air along a core flowpath C for compression and communication into the combustor section 26 then expansion through the turbine section 28. Although depicted as a turbofan gas turbine engine 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 including three-spool architectures.

[0028] The engine 20 generally includes a low speed spool 30 and a high speed spool 32 mounted for rotation about an engine central longitudinal axis A 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.

[0029] The low speed spool 30 generally includes an inner shaft 40 that interconnects a fan 42, a low pressure compressor 44 and a low pressure turbine 46. The inner shaft 40 is connected to the fan 42 through 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 compressor 52 and high pressure turbine 54. A combustor 56 is arranged between the high pressure compressor 52 and the high pressure turbine 54. 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 supports one or more bearing systems 38 in the turbine section 28. The inner shaft 40 and the outer shaft 50 are concentric and rotate via bearing systems 38 about the engine central longitudinal axis A, which is collinear with their longitudinal axes.

[0030] The core airflow C is compressed by the low pressure compressor 44 then the high pressure compressor 52, mixed and burned with fuel in the combustor 56, then expanded over the high pressure turbine 54 and low pressure turbine 46. The mid-turbine frame 57 includes airfoils 59 which are in the core airflow path. The turbines 46, 54 rotationally drive the respective low speed spool 30 and high speed spool 32 in response to the expansion.

[0031] The engine 20 in one example a high-bypass geared aircraft engine. In a further example, the engine 20 bypass ratio is greater than about six (6), with an example embodiment being greater than ten (10), the geared architecture 48 is an epicyclic gear train, such as a planetary gear system or other gear system, with a gear reduction ratio of greater than about 2.3 and the low pressure turbine 46 has a pressure ratio that is greater than about 5. In one disclosed embodiment, the engine 20 bypass ratio 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 5:1. Low pressure turbine 46 pressure ratio is pressure measured prior to inlet of low pressure turbine 46 as related to the pressure at the outlet of the low pressure turbine 46 prior to an exhaust nozzle. The geared architecture 48 may be an epicycle gear train, such as a planetary gear system or other gear system, with a gear reduction ratio of greater than about 2.5:1. It should be understood, however, that the above parameters are only exemplary of one embodiment of a geared architecture engine and that the present invention is applicable to other gas turbine engines including direct drive turbofans.

[0032] 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 lbm of fuel being burned divided by lbf of thrust the engine produces at that minimum point. “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 1.45. “Low corrected fan tip speed” is the actual fan tip speed in ft/sec divided by an industry standard temperature correction of $[(\text{Tram } °\text{R}) / (518.7\ °\text{R})]^{0.5}$. The

"Low corrected fan tip speed" as disclosed herein according to one non-limiting embodiment is less than about 1150 ft / second.

[0033] An example buffer system 60 is illustrated in Figure 2. The system 60 includes first, second and third air sources 62, 64, 66, which are different than one another in the example. In one example, one of the first and second air sources 62, 64 is provided by the high pressure compressor 52. The third air source 66 is provided by the low pressure compressor 44. A pressurized region 100 between the exit of the low pressure compressor 44 and the exit of high pressure compressor 52 is referred to as "mid-stage" (100 in Figure 1) and is arranged fluidly with the low and high pressure compressors 44, 52 within the compressor section 24. In the example, the first and second air sources 62, 64 are provided within the high pressure compressor but could be representative of any two differing pressure supplies. Thus, in one example, the first air source 62 provides air at a low pressure and temperature state, the second air source 64 provides air at a higher pressure and temperature state, and the third air source 66 provides low pressure compressor air.

[0034] The first and second air sources 62, 64 are selectively fluidly coupled to a heat exchanger 72. In one example, a valve 68 is fluidly coupled to the first and second air sources 62, 64 and is configured to regulate fluid flow from the first and second air sources 62, 64 to the heat exchanger 72.

[0035] The heat exchanger 72 includes a first inlet and outlet 69, 70 and a second inlet and outlet 71, 73. The first outlet 70 provides cooled pressurized air 74. Passages are provided between respective inlets and outlets and are configured to transfer heat between the passages. In the example, the valve 68 is fluidly coupled to the first inlet 69, and the third air source 66 is fluidly coupled to the second inlet 71. The second outlet 73 is fluidly coupled to the bypass flow B so that low pressure compressor air expelled from the heat exchanger 72 may be used to supplement the thrust provided by the bypass flow B.

[0036] The first outlet 70 is fluidly coupled to multiple fluid-supplied areas that are located remotely from one another. The multiple fluid-supplied areas include multiple bearing compartments 76A, 76B, 76C, 76D. The multiple fluid-supplied areas may also include a component 78 that requires thermal conditioning, such as a vane, blade or clearance control device. The multiple fluid-supplied areas may also include a rotor 80 in the high pressure compressor 52 and/or a low pressure turbine section shaft 82.

[0037] In operation, a method of providing pressurized air to the gas turbine engine 10 includes selectively providing pressurized air from multiple air sources to the heat exchanger 72 to cool the pressurized air. The cooled pressurized air 74 is distributed to multiple fluid-supplied areas within the gas turbine engine. In one example, air from first and second air sources 62, 64, which are different from one another, are regulated. The pressurized air is cooled by providing low pressure compressor air from a third air source 66 to the heat exchanger 72. The cooled pressurized air 74 is distributed to multiple bearing compartments 76A, 76B, 76C, 76D, high pressure compressor section rotor 80, low pressure turbine section shaft 82, and/or a component 78.

[0038] 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 the claims. For that reason, the following claims should be studied to determine their true scope and content.

CLAIMS

What is claimed is:

1. A buffer system for a gas turbine engine comprising:

a heat exchanger having a first inlet and outlet and a second inlet and outlet, the first outlet configured to provide a cooled pressurized fluid;

first and second air sources selectively fluidly coupled to the first inlet;

a third air source fluidly coupled to the second inlet; and

multiple fluid-supplied areas located remotely from one another and fluidly coupled to the first outlet, the multiple fluid-supplied areas including multiple bearing compartments.

2. The buffer system according to claim 1, wherein the first, second and third air sources are different than one another.

3. The buffer system according to claim 2, comprising low and high pressure compressors, one the first and second air sources is provided by the high pressure compressor, and the third air source provided by the low pressure compressor.

4. The buffer system according to claim 3, wherein a valve is fluidly coupled to at least one of the first and second air sources, the valve configured to regulate fluid flow from the first and second air sources to the heat exchanger.

5. The buffer system according to claim 3, wherein a mid-stage is provided fluidly between the low and high pressure compressor exits, the other of the first and second air sources provided by the mid-stage.

6. The buffer system according to claim 1, comprising a high pressure compressor including a rotor, and the multiple fluid-supplied areas including the rotor.

7. The buffer system according to claim 1, comprising a low pressure turbine including a shaft, and the multiple fluid-supplied areas including the shaft.

8. The buffer system according to claim 1, comprising a component, and the multiple fluid-supplied areas including the component, which is configured to be cooled by the cooled pressurized fluid.

9. The buffer system according to claim 1, comprising a bypass flow path arranged between core and fan nacelles, the second outlet fluidly coupled to the bypass flow path.

10. The buffer system according to claim 9, comprising a low pressure compressor fluidly coupled to the second inlet.

11. A method of providing pressurized air in a gas turbine engine, the method comprising:

selectively providing pressurized air from multiple air sources to a heat exchanger to cool the pressurized air; and

distributing the cooled pressurized air to multiple fluid-supplied areas within the gas turbine engine.

12. The method according to claim 11, wherein the selectively providing step includes regulating air from first and second air sources that have different pressures.

13. The method according to claim 11, comprising the step of cooling the pressurized air by providing low pressure compressor air to the heat exchanger.

14. The method according to claim 11, wherein the distributing step includes providing the cooled pressurized air to multiple bearing compartments.

15. The method according to claim 11, wherein the distributing step includes providing the cooled pressurized air to at least one of a high pressure compressor rotor, a low pressure turbine shaft, and a component.

16. A gas turbine engine comprising:

a fan;

a compressor section fluidly connected to the fan;

a combustor fluidly connected to the compressor section;

a turbine section fluidly connected to the combustor; and

a buffer system comprising:

a heat exchanger having a first inlet and outlet and a second inlet and outlet, the first outlet configured to provide a cooled pressurized fluid;

first and second air sources selectively fluidly coupled to the first inlet;

a third air source fluidly coupled to the second inlet; and

multiple fluid-supplied areas located remotely from one another and are fluidly coupled to the first outlet, the multiple fluid-supplied areas including multiple bearing compartments.

17. The gas turbine engine according to claim 16, wherein the gas turbine engine is a high bypass geared aircraft engine having a bypass ratio of greater than about six (6).

18. The gas turbine engine according to claim 16, wherein the gas turbine engine includes a low Fan Pressure Ratio of less than about 1.45.

19. The gas turbine engine according to claim 16, wherein the low pressure turbine has a pressure ratio that is greater than about 5.

20. The gas turbine engine according to claim 16, wherein the first, second and third air sources are different than one another.

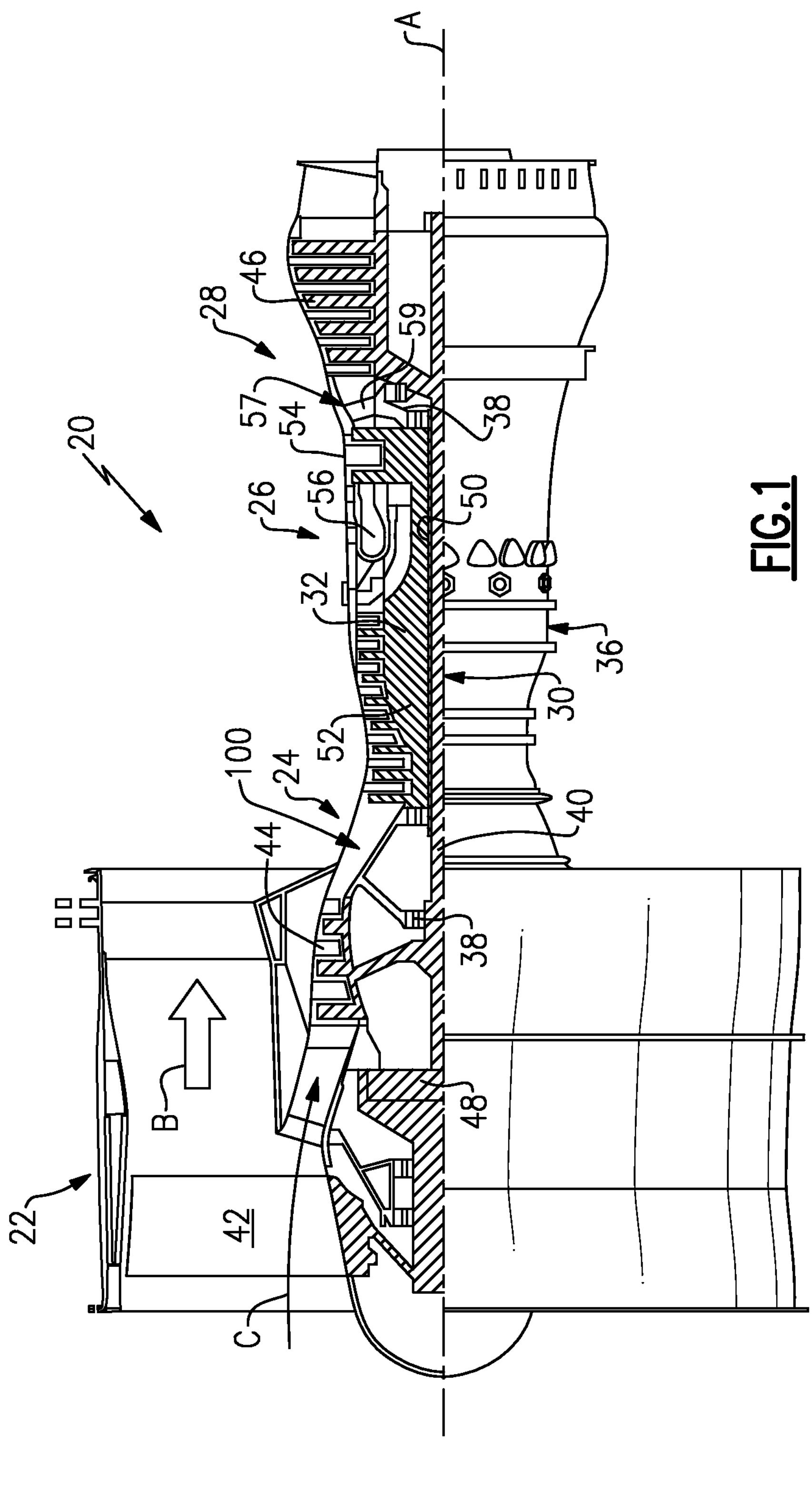
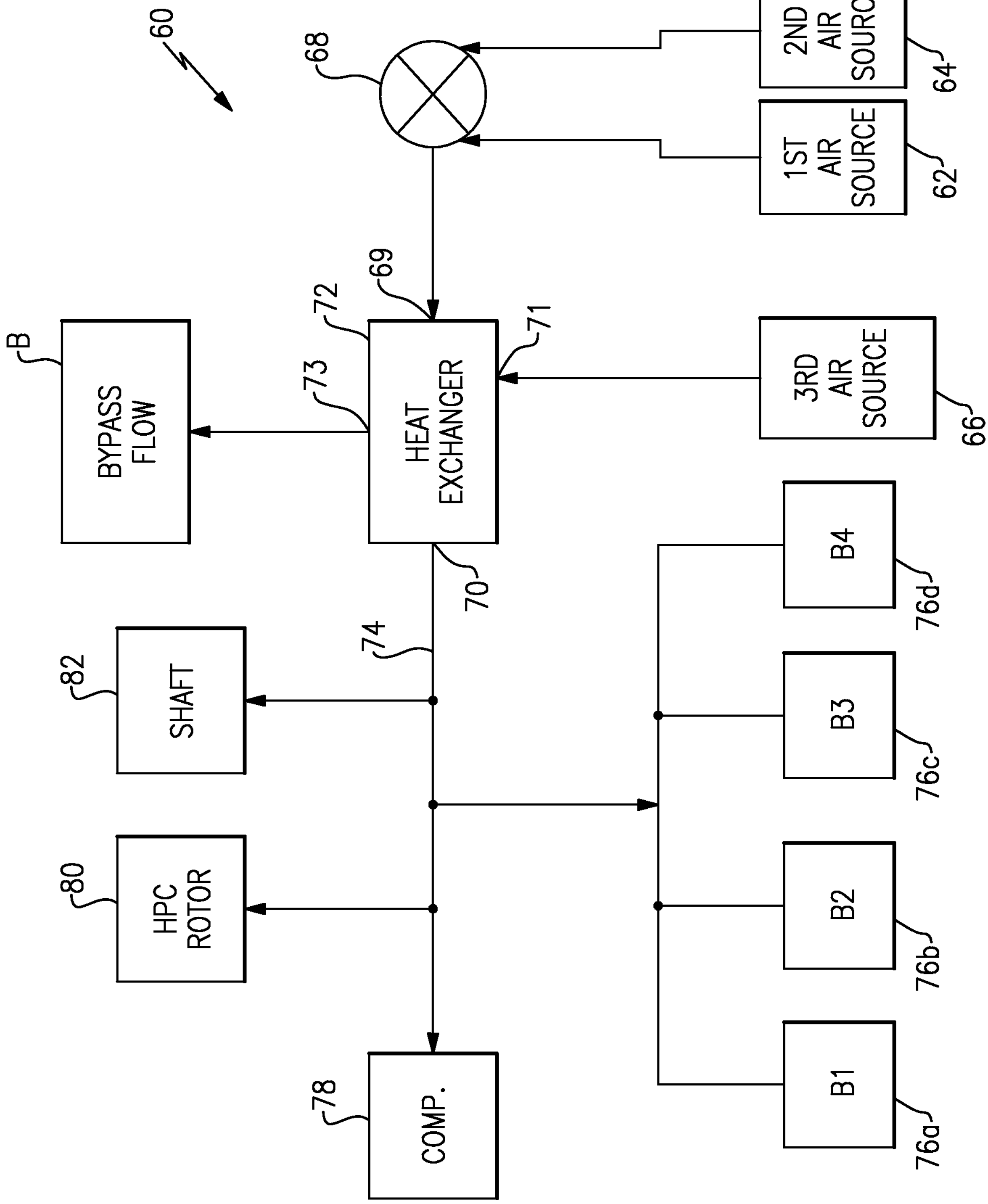


FIG.1

FIG.2


60
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76c
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HPC ROTOR
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COMP.
B1
76a

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US13/20746

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F02C 6/08 (2013.01) USPC - 60/337, 782 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)
IPC(8) Classification(s): F02C 6/00, 6/08, 7/12 (2013.01)
USPC Classification(s): 60/39.512, 39.52, 337, 782, 785, 805; 123/41.62

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 practicable, search terms used)
MicroPatent (US Granted, US Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); DialogPro (Derwent, INSPEC, NTIS, PASCAL, Current Contents Search, Dissertation Abstracts Online, Inside Conferences); Google.com; Google.com/Scholar; turbine, generator, heat adj exchanger, bypass, engine, bearing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,305,156 B1 (LUI, C) October 23, 2001; figure 1; column 3, lines 15-25; column 3, lines 25-30	11-13, 15 --- 1-10, 14, 16-20
Y	US 4,542,623 A (HOVAN, EJ et al.) September 24, 1985; figure 3; column 2, lines 65-68; column 3, lines 1-11	1-10, 14, 16-20
Y	US 6,035,627 A (LIU, X) March 14, 2000; figures 1, 2; column 3, lines 10-15	6, 7, 9, 10
Y	US 8,074,440 B2 (KOHLENBERG, GA et al.) December 13, 2011; column 2, lines 45-50	17, 19
Y	US 4,709,880 A (BRADFIELD, GW et al.) December 1, 1987; column 7, lines 1-10	18

☐ Further documents are listed in the continuation of Box C. ☐

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Date of the actual completion of the international search	Date of mailing of the international search report
29 August 2013 (29.08.2013)	05 SEP 2013

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774