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KZ, LA, LC, LK, LR, LS, 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.

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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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27 October 2016

(54) Title: FLAMESHEET COMBUSTOR CONTOURED LINER

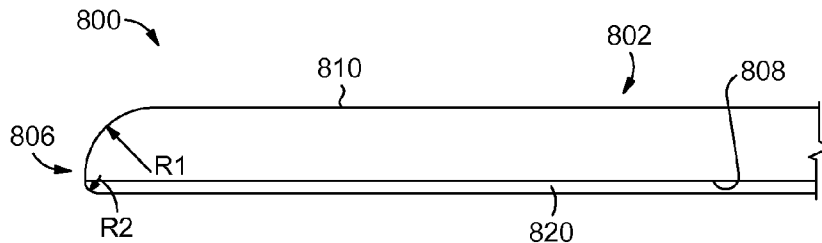


FIG. 10.

(57) Abstract: The present invention discloses a novel apparatus and way for reducing the recirculation zone at the inlet end of a combustor. The recirculation zone is reduced by altering the geometry of the inlet end through a tapering of the liner wall thickness and a tapering of the thermal barrier coating to reduce the bluff body effect at the combustion liner inlet end.

WO 2016/099805 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 15/61926

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - F23R 3/42, F23R 3/00, F23R 3/42 (2016.01) CPC - F23R 3/346, F23R 3/42, F23R 3/54, F23R 3/42 According to International Patent Classification (IPC) or to both national classification and IPC</p>																													
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) IPC (8): F23R3/00, F23R3/42, F23R3/54, F23R3/60 (2016.01) CPC: F23R3/346, F23R3/42, F23R3/54, F23R3/60</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC: 60/752, 60/755, 60/756, 60/772, 60/776, 60/796</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Patbase, Google (Web, Images, Patents, Scholar) Liner, combustion, turbine, coating, thickness, contour, shape, radial, radius, bend, air, fuel, inlet, chamber, edge, bond, bevel, angle, porous, crack, dense</p>																													
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>US 7,237,384 B2 (Stuttaford et al.) 03 July 2007 (03.07.2007) entire document, especially Title, Abstract, figs. 3-4, col 2, ln 26-33, col 3, ln 5-11.</td> <td>1-21</td> </tr> <tr> <td>Y</td> <td>EP 0136071 B1 (WESTINGHOUSE ELECTRIC CORPORATION) 07 January 1988 (07.01.1988) entire document, especially figs. 1-3, col 2, ln 20-65, col 3, ln 36-40.</td> <td>1-21</td> </tr> <tr> <td>Y</td> <td>US 6,047,539 A (Farmer) 11 April 2000 (11.04.2000) entire document, especially Title; Abstract col 2, ln 38-52, col 3, ln 20-25, 52-56</td> <td>6, 11</td> </tr> <tr> <td>Y</td> <td>US 2014/0090390 A1 (STUTTAFORD et al.) 03 April 2014 (03.04.2014) entire document.</td> <td>13-15</td> </tr> <tr> <td>Y</td> <td>US 7,770,395 B2 (Tanimura) 10 August 2010 (10.08.2010) entire document, especially Title, Abstract, figs. 1-2, col 5, ln 4-16, 24-29.</td> <td>16-19, 21</td> </tr> <tr> <td>A</td> <td>US 2007/0202269 A1 (Potter et al.) 30 August 2007 (30.08.2007) entire document, especially para [0017]-[0019]</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>US 2003/0203224 A1 (DiConza et al.) 30 October 2003 (30.10.2003) entire document, especially para [0019])</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>US 2011/0048017 A1 (MARGOLIES et al.) 03 March 2011 (03.03.2011) entire document, especially Title; Abstract, fig. 1; para[0024]-[0025].</td> <td>1-21</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	US 7,237,384 B2 (Stuttaford et al.) 03 July 2007 (03.07.2007) entire document, especially Title, Abstract, figs. 3-4, col 2, ln 26-33, col 3, ln 5-11.	1-21	Y	EP 0136071 B1 (WESTINGHOUSE ELECTRIC CORPORATION) 07 January 1988 (07.01.1988) entire document, especially figs. 1-3, col 2, ln 20-65, col 3, ln 36-40.	1-21	Y	US 6,047,539 A (Farmer) 11 April 2000 (11.04.2000) entire document, especially Title; Abstract col 2, ln 38-52, col 3, ln 20-25, 52-56	6, 11	Y	US 2014/0090390 A1 (STUTTAFORD et al.) 03 April 2014 (03.04.2014) entire document.	13-15	Y	US 7,770,395 B2 (Tanimura) 10 August 2010 (10.08.2010) entire document, especially Title, Abstract, figs. 1-2, col 5, ln 4-16, 24-29.	16-19, 21	A	US 2007/0202269 A1 (Potter et al.) 30 August 2007 (30.08.2007) entire document, especially para [0017]-[0019]	1-21	A	US 2003/0203224 A1 (DiConza et al.) 30 October 2003 (30.10.2003) entire document, especially para [0019])	1-21	A	US 2011/0048017 A1 (MARGOLIES et al.) 03 March 2011 (03.03.2011) entire document, especially Title; Abstract, fig. 1; para[0024]-[0025].	1-21
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<p>Date of the actual completion of the international search 28 June 2016</p>		<p>Date of mailing of the international search report 07 SEP 2016</p>																											
<p>Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300</p>		<p>Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774</p>																											

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/61926

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-6, 20-21, drawn to a combustion liner, per se, having an outer surface contoured profile.

Group II: Claims 7-12, drawn to an inlet portion of a combustion liner having a rate of taper of liner and coating thickness.

Group III: Claims 13-15, drawn to a method of reducing a recirculation zone.

Group IV: Claims 16-19, drawn to a combustion liner having a first and second blended radius contour.

-*-See Extra Sheet*-*

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/61926

-*-Box III-*-* Observations where unity of invention is lacking-*-

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical feature(s) for the following reasons:

SPECIAL TECHNICAL FEATURES

Group I has the special technical feature(s) of first and second outer surfaces, not required by Groups II-IV.

Group II has the special technical feature(s) of a first liner thickness, a second liner thickness, and a rate of taper of said thicknesses at the inlet; and first and second coating thickness having a second rate of taper between said thicknesses, not required by Groups I, III or IV.

Group III has the special technical feature(s) of a method of reducing a recirculation zone in a combustion liner comprising the steps of directing a fuel and air mixture along the outer surface of the combustion liner, turning the fuel and air mixture about an inlet end of the combustion liner such that the mixture remains at least in close proximity to the chamfered portions of the combustion liner and, directing the mixture into the combustion liner, not required by Groups I-II or IV.

Group IV has the special technical feature(s) of a liner having a generally annular body having an opposing surface contoured according to a first radius; and a coating applied to an inner surface of the liner, the coating contoured according to a second radius, such that the first radius blends into the second radius at the inlet end, not required by Groups I-III.

COMMON TECHNICAL FEATURES

The only technical feature(s) that would otherwise unify Groups I-IV are a combustion liner, comprising an inlet and an outlet, and an inner surface and an outer surface, and a coating applied to the inner surface of the combustion liner. However, these shared technical feature(s) do not represent a contribution over the prior art as they are obvious over US 7,237,384 B2 to Stuttaford et al. (hereinafter 'Stuttaford') in view of EP 0136071 B1 to WESTINGHOUSE ELECTRIC CORPORATION (hereinafter 'WESTINGHOUSE').

Stuttaford teaches a combustion liner (73; fig.4; col 2, ln 26-33) comprising an inlet end (generally 88 within and at inlet terminating end of liner 73; fig. 4), and an opposing outlet end (see opposing outlet end not labeled; figs. 3-4), an inner surface and an opposing outer surface (see fig. 4; wherein liner 73 has an inner surface facing conduit 79 and an outer surface 73; col 3, ln 5-11).

WESTINGHOUSE teaches a thermal resistant coating (16) for the combustion liner (10) of a turbine combustion engine (col 2, ln 20-35; figs. 1-3).

It would have been obvious to a person having ordinary skill in the art that the liner taught by Stuttaford could have been modified in view of WESTINGHOUSE to include a thermally resistant coating, to improve the performance of the liner.

As the common feature(s) of Groups I-IV were known in the art at the time of the invention, they cannot be considered special technical feature(s) that would otherwise unify the groups.

The only common technical feature(s) that would otherwise unify Groups I-II and IV are a combustion liner having a generally annular body. However, these technical feature(s) do not represent a contribution to the prior art, because they are anticipated by Stuttaford.

Stuttaford teaches a combustion liner (73; fig.4; col 2, ln 26-33) comprising a generally annular body (see annular body of liner 73; fig.3).

As the common feature(s) of Groups I-II and IV were known in the art at the time of the invention, they cannot be considered special technical feature(s) that would otherwise unify the groups.

The only common technical feature(s) that would otherwise unify Groups I-II are a combustion liner having a tapered coating. However, these technical feature(s) do not represent a contribution to the prior art, because they are obvious over Stuttaford in view of WESTINGHOUSE.

Stuttaford teaches a combustion liner (73; fig.4; col 2, ln 26-33).

WESTINGHOUSE teaches a thermal resistant coating (16) for a combustion liner (10) of a turbine combustion engine (col 2, ln 20-35; figs. 1-3) wherein said coating (16) including a ceramic coating portion (col 2, ln 32-35, 46-61) having a varying thickness from the inlet end (12; fig. 2) to reduce the impact on airflow to the liner by avoiding excess thermal resistant coating at areas that do not receive high temperature conditions (col 2, ln 62-65, col 3, ln 36-40).

It would have been obvious to one having ordinary skill in the art that the combustion liner taught by Stuttaford could have been modified in view of WESTINGHOUSE to reduce the impact on airflow to the liner by avoiding excess thermal resistant coating at areas that do not receive high temperature conditions.

The common technical feature(s) that would otherwise unify Groups I and III are a combustion liner having a chamfer along an outer surface of the combustion liner and a coating applied to an inner surface of the combustion liner. However, these shared technical feature(s) do not represent any contribution of the prior art as the shared technical feature(s) are obvious over Stuttaford in view of WESTINGHOUSE.

-*-Continued in Next Sheet-*-

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/61926

-*Continued from Previous Sheet-*

Stuttaford teaches a combustion liner (73; fig.4; col 2, ln 26-33) comprising: a generally annular body (see annular body of liner 73; fig.3), an inlet end (generally 88 within and at inlet terminating end of liner 73; fig. 4), and an opposing outlet end (see opposing outlet end not labeled; figs. 3-4), the generally annular body having an inner surface and an opposing outer surface (see fig. 4; wherein liner 73 has an inner surface facing conduit 79 and a contoured outer surface of 73 varying in thickness forming channel 88 and facing annular wall 77; col 3, ln 5-11), and a first chamfer extending from the first outer surface to the inlet end (see terminating edge of liner 73 having a chamfer).

WESTINGHOUSE teaches a thermal resistant coating (16) for the combustion liner (10) of a turbine combustion engine (col 2, ln 20-35; figs. 1-3) wherein said coating (16) includes a bond coating (col 2, ln 46-52) and a ceramic coating (col 2, ln 32-35, 46-61) said ceramic coating having a varying thickness from the inlet end (12; fig. 2) to reduce the impact on airflow to the liner by avoiding excess thermal resistant coating at areas that do not receive high temperature conditions (col 2, ln 62-65, col 3, ln 36-40).

It would have been obvious to one having ordinary skill in the art that the combustion liner taught by Stuttaford could have been modified in view of WESTINGHOUSE to provide a thermal resistant coating to improve the performance and service life of the liner.

As the common feature(s) of Groups I and III were known in the art at the time of the invention, they cannot be considered special technical feature(s) that would otherwise unify the groups.

The shared technical feature(s) that would otherwise unify Groups I and IV are a combustion liner having a contoured profile, and that the coating comprises a bond coating and a ceramic coating. However, these shared technical feature(s) do not represent a contribution over the prior art as being obvious over Stuttaford in view of WESTINGHOUSE.

Stuttaford teaches a combustion liner (73; fig.4; col 2, ln 26-33) comprising: a generally annular body having a contoured outer surface having a contoured profile proximate the inlet (see fig.4; wherein outer surface of 73 has a varied thickness along its length) end such that the outer surface comprises a first outer surface (see largest thickness of 73 located proximal to the inlet generally at 88, creating a choked region for the fuel air flow; fig. 4) and a second outer surface (see second outer surface generally flat thickness labeled 73; fig. 4) with the first outer surface located radially outward of the second outer surface (see fig. 4; showing the tapered region from the larger thickness of the first outer surface generally at 88, to the smaller thickness of the second outer surface generally 73).

WESTINGHOUSE teaches a thermal resistant coating (16) for the combustion liner (10) of a turbine combustion engine (col 2, ln 20-35; figs. 1-3) wherein said coating (16) includes a bond coating (col 2, ln 46-52) and a ceramic coating (col 2, ln 32-35, 46-61).

It would have been obvious to a person having ordinary skill in the art that the combustion liner taught by Stuttaford could have been modified in view of WESTINGHOUSE, to provide a combustion liner having an inner surface coating comprising both a bond coating and a ceramic top coating, to permit further resistance to the high temperatures experienced in the liner due to combustion of the air-fuel mixture.

As the common technical feature(s) of Groups I and IV were known in the art at the time of the invention, they cannot be considered special technical feature(s) that would otherwise unify the groups.

Therefore, Groups I-IV lack unity under PCT Rule 13 because they do not share the same or corresponding special technical feature(s).