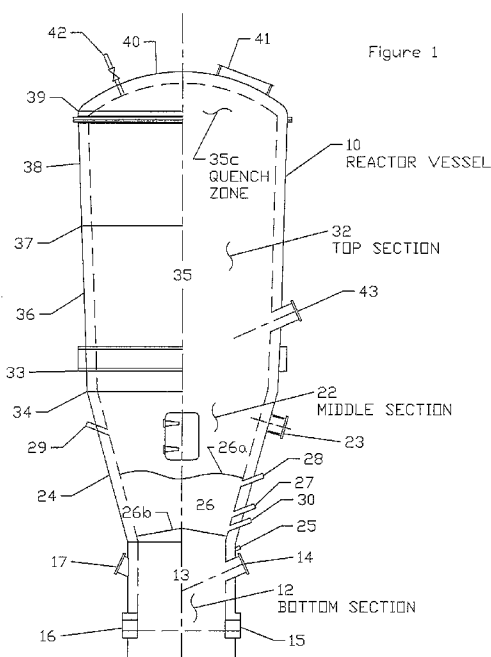




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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, 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, 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.
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[Continued on next page]

(54) **Title:** ENHANCED PLASMA GASIFIERS FOR PRODUCING SYNGAS

(57) **Abstract:** A plasma gasification reactor, and process for its operation, with one or both of, first, a quench zone within an upper part of a top section of the reactor and, second, feed ports through a lateral wall of a middle section of the reactor for supplying feed material to a feed bed within the middle section and the feed ports located proximate the feed bed. The quench zone is provided with nozzles for introducing a fluid to reduce the temperature of molten solid bits sufficiently to minimize their sticking within external ductwork. The middle section feed port arrangement assists in more thorough reaction of light particles in the feed material that may otherwise exit with gaseous products. Among feed port arrangements, they may be located above a feed bed and angled upwardly to allow close proximity to the upper feed bed surface without severe radiation heating or they may be located at a level to feed material laterally directly into a feed bed, in which case a cooling arrangement may be provided, as well as a feed mechanism, to facilitate passage of feed material.

**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))*

Published:

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

(88) Date of publication of the international search report:
21 March 2013

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/021060

A. CLASSIFICATION OF SUBJECT MATTER INV. C10J3/18 C10J3/72 ADD.		
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) C10J		
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) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/093553 A2 (ALTER NRG CORP [CA]; DIGHE SHYAM V [US]; DARR MARK F [US]; MARTORELL I) 19 August 2010 (2010-08-19) paragraph [0019] - paragraph [0085]; figure 1	1-24
A	----- US 2008/299019 A1 (DIGHE SHYAM V [US] ET AL) 4 December 2008 (2008-12-04) the whole document	1-24
A	----- US 2009/064581 A1 (NIELSEN MATTHEW CHRISTIAN [US] ET AL) 12 March 2009 (2009-03-12) the whole document	1-24
A	----- US 2006/112639 A1 (NICK PETER A [US] ET AL) 1 June 2006 (2006-06-01) the whole document -----	1-24
☐ 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 19 June 2012	Date of mailing of the international search report 03/12/2012	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Iyer-Baldew, A	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/021060

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:

see additional 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 an 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.:

1-24

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

Information on patent family members

International application No

PCT/US2012/021060

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010093553	A2	19-08-2010	
		AU 2010213982 A1	18-08-2011
		CA 2751859 A1	19-08-2010
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		US 2010215554 A1	26-08-2010
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US 2009064581	A1	12-03-2009	NONE

US 2006112639	A1	01-06-2006	NONE

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-24

A plasma gasifier and process for gasification using a refractory-lined reactor vessel with a bottom section containing a carbonaceous bed, a middle section containing a bed of deposited feed material, and a top section including a freeboard region in a lower part of the top section and a quench zone in an upper part of the top section a roof over the quench zone, the top section including one or more syngas outlets connected with external ductwork and, an arrangement of a plurality of quench fluid inlets for injecting fluid into the quench zone.

2. claim: 25

A plasma gasifier comprising a bottom section with a carbonaceous bed and one or more plasma torch inlets; a middle section with one or more lateral feed ports for supplying feed material to form a feed bed atop the carbonaceous bed of the bottom section, said feed ports being oriented at an upward angle and located above and proximate to the feed bed upper surface.

3. claim: 26

A plasma gasifier comprising a bottom section with a carbonaceous bed and one or more plasma torch inlets; a middle section with one or more lateral feed ports for supplying feed material to form a feed bed atop the carbonaceous bed of the bottom section, said feed ports including one or more feed ports located at a level below the feed bed upper surface.
