

EXHIBIT 2

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: **FRANK OCCHIUTI
OCCHIUTI & ROHLICEK LLP
321 SUMMER STREET
BOSTON, MA 02210**

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year) **19 OCT 2015**

Applicant's or agent's file reference 60040-003WO1		FOR FURTHER ACTION See paragraph 2 below
International application No. PCT/US2015/042353	International filing date (day/month/year) 28 July 2015	Priority date (day/month/year) 01 August 2014
International Patent Classification (IPC) or both national classification and IPC IPC(8) - F24J 1/00 (2015.01) CPC - F24J 1/00 (2015.09)		
Applicant ROSSI, ANDREA		

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Date of completion of this opinion 21 September 2015	Authorized officer Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774
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Box No. 1 Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

- the international application in the language in which it was filed.
- a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

- a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
- b. furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
- c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
 - on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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Box No. V	Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement		
1. Statement			
Novelty (N)	Claims	1-28, 30, 31, 35, 36	YES
	Claims	29, 32-34	NO
Inventive step (IS)	Claims	19-28	YES
	Claims	1-18, 29-36	NO
Industrial applicability (IA)	Claims	1-36	YES
	Claims	None	NO
2. Citations and explanations:			
<p>Claims 29 and 32-34 lack novelty under PCT Article 33(2) as being anticipated by Mills.</p> <p>Regarding claim 29, Mills discloses an apparatus for heating a fluid, said apparatus comprising means for containing said fluid, and means for holding a fuel mixture containing a catalyst and a reagent, and means for initiating a reaction sequence mediated by said catalyst to cause an exothermic reaction [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146].</p> <p>Regarding claim 32, Mills discloses a composition of matter for generating heat, said composition comprising a fuel mixture and a catalyst, said catalyst comprising a group 10 element such as nickel [see Paras. 0141, 0142, 0144, and 0146].</p> <p>Regarding claim 33, Mills discloses the composition of claim 32, wherein said catalyst comprises nickel [see Paras. 0142 and 0144].</p> <p>Regarding claim 34, Mills discloses the composition of claim 32, wherein said catalyst comprises nickel powder [see Paras. 0142, 0144, 0188, and 0195].</p> <p>Claim 35 lacks an inventive step under PCT Article 33(3) as being obvious over Mills.</p> <p>Regarding claim 35, Mills discloses the composition of claim 34. Mills fails to explicitly disclose the composition, wherein said nickel powder has been treated to enhance porosity thereof. It is submitted that the supports utilized in the fuel mixture or composition of Mills would appear to enhance the porosity of the nickel powder [see Paras. 0146, 0164, 0185, and 0188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the composition of Mills by including the recited nickel powder, for the purpose of optimizing the generation of heat from the fuel mixture.</p> <p>Claims 1, 2, and 6-16 lack an inventive step under PCT Article 33(3) as being obvious over Coffey et al. (hereafter Coffey) in view of Mills.</p> <p>Regarding claim 1, Coffey discloses an apparatus for heating fluid, said apparatus comprising a tank for holding fluid to be heated, and a fuel wafer in fluid communication with said fluid, said fuel wafer including a fuel mixture including reagents or reactant powders, and an ignition source in thermal communication with said fuel mixture, wherein the ignition source is selected from the group consisting of an induction heater, an electrical resistor, a heater that relies on natural gas combustion, and a heater that relies on combustion of fuel [see Figs. 12, 17, and 20, and Paras. 0007, 0072, 0085 and 0090]. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer including a fuel mixture including reagents and a catalyst. Mills teaches that it is known in the art to include fuel mixture comprising reagents and a catalyst in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited fuel mixture in view of the teachings of Mills, for the purpose of optimizing the generation of heat from a desired fuel mixture.</p> <p>Regarding claim 2, Coffey in view of Mills discloses the apparatus of claim 1. Coffey further discloses the apparatus, wherein said ignition source comprises an electrical resistor [see Fig. 20 and Para. 0090].</p> <p>Regarding claim 6, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said catalyst comprises nickel powder. Mills teaches that it is known in the art to include fuel mixture comprising nickel powder catalyst in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited catalyst in view of the teachings of Mills, for the purpose of optimizing the generation of heat from a desired fuel mixture.</p>			

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Continuation of:

Regarding claim 7, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said nickel powder has been treated to enhance porosity thereof. Mills teaches that it is known in the art to utilize a support for nickel powder catalyst in a fuel mixture, which would appear to enhance the porosity of the nickel powder [see Paras. 0164 and 0185 and 0188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited nickel powder in view of the teachings of Mills, for the purpose of optimizing the generation of heat from the fuel mixture.

Regarding claim 8, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said catalyst comprises a group 10 element. Mills teaches that it is known in the art to include fuel mixture comprising group 10 element such as nickel in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited catalyst in view of the teachings of Mills, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 9, Coffey in view of Mills discloses the apparatus of claim 1. Coffey further discloses the apparatus, further comprising a voltage source in electrical communication with said ignition source [see Fig. 20 and Para. 0090].

Regarding claim 10, Coffey in view of Mills discloses the apparatus of claim 2. Coffey further discloses the apparatus, further comprising a voltage source in electrical communication with said ignition source [see Fig. 20 and Para. 0090].

Regarding claim 11, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer comprises a multi-layer structure having a layer of said fuel mixture in thermal communication with a layer containing said ignition source. Mills teaches that it is known in the art to utilize fuel mixture with a multi-layer structure containing a metal catalyst and support in an apparatus for heating a fluid [see Figs. 1 and 20, and Paras. 0144, 0185, and 188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited multi-layer structure in view of the teachings of Mills, since where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable arrangement of fuel mixture and ignition source in the multi-layer structure involves only routine skill in the art, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 12, Coffey in view of Mills discloses the apparatus of claim 2. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer comprises a multi-layer structure having a layer of said fuel mixture in thermal communication with a layer containing said ignition source. Mills teaches that it is known in the art to utilize fuel mixture with a multi-layer structure containing a metal catalyst and support in an apparatus for heating a fluid [see Fig. 1, and Paras. 0144, 0185, and 0188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited multi-layer structure in view of the teachings of Mills, since where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable arrangement of fuel mixture and ignition source in the multi-layer structure involves only routine skill in the art, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 13, Coffey discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer comprises a central heating insert and a pair of fuel inserts disposed on either side of said heating insert. Coffey discloses that it is known in the art to utilize a central heating insert in a container filled with a fuel or solid state heating composition [see Fig. 14A, and Para. 0073]. Coffey further discloses the use of other geometries to define various path shapes, lengths, and thicknesses, and the use of different particle shapes, size, and ratios for the heating and reaction regulator elements [see Paras. 0072 and 0073]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited catalyst in view of the teachings of Mills, since where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable arrangement of the central heating and fuel inserts involves only routine skill in the art, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 14, Coffey in view of Mills discloses the apparatus of claim 1. Coffey further discloses the apparatus, wherein said tank comprises a recess for receiving said fuel wafer therein [see Fig. 17, and Para. 0085].

Regarding claim 15, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said tank further comprises a door or safety seal for sealing said recess [see Fig. 17 and Para. 0085].

Regarding claim 16, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said tank comprises a radiation shield. It is submitted that the inert layers utilized in the tank of Coffey are considered indistinguishable from the recited radiation shield [see Fig. 13 and Para. 0075]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited radiation shield, for the purpose of preventing heat dissipation to the external surfaces of the tank.

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Continuation of:

Claims 30, 31, and 36 lack an inventive step under PCT Article 33(3) as being obvious over Mills in view of Hudson.

Regarding claim 30, Mills discloses the apparatus of claim 29. Mills fails to explicitly disclose the apparatus, wherein said catalyst that comprises a group 10 element and a reagent comprises lithium and lithium aluminum hydride, said apparatus further comprising means for periodically reinvigorating said reaction sequence. Hudson teaches that it is known in the art to include a catalyst comprising a group 10 element such as nickel and a reagent comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. It is submitted that the apparatus of Mills appears to include a reactor wherein reactants are continuously supplied and side products are continuously removed and regenerated and returned to the reactor, which would appear to reinvigorate the reaction sequence [see Para. 0147]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Mills by including the recited catalyst and means for periodically reinvigorating the reaction sequence in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from the fuel mixture.

Regarding claim 31, Mills discloses a composition of matter for generating heat, said composition comprising a mixture of nickel powder, lithium powder, and aluminum hydride powder [see Paras. 0141, 0142, 0144, and 0146]. Mills fails to explicitly disclose the composition of matter for generating heat comprising a mixture of porosity enhanced nickel powder, lithium powder, and lithium aluminum powder. It is submitted that the supports utilized in the fuel mixture or composition of Mills would appear to enhance the porosity of the nickel powder [see Paras. 0146, 0164, 0185, and 0188]. Hudson teaches that it is known in the art to include a catalyst comprising a group 10 element such as nickel and a reagent comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the composition of Mills by including the recited mixture in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from a fuel mixture.

Regarding claim 36, Mills discloses a method of heating a fluid, said method comprising placing a mixture of nickel powder, lithium powder and aluminum hydride in thermal communication with said fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]; and heating said mixture thereby initiating an exothermic reaction in said mixture [see Fig. 3, and Paras. 0157 and 0167]. Mills fails to explicitly disclose the method comprising placing a mixture of nickel powder, lithium powder and lithium aluminum hydride in thermal communication with said fluid. Hudson teaches that it is known in the art to utilize a mixture of nickel powder, lithium, and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the method of Mills by including the recited mixture in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from a fuel mixture.

Claim 3 lacks an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and Rohrbaugh et al. (hereafter Rohrbaugh)

Regarding claim 3, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said ignition source comprises an induction heater. Rohrbaugh teaches that it is known in the art to utilize an induction heater in a heating system for a metal strip [see Fig. 1 and Col. 3 Lns. 13-26]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited induction heater in view of the teachings of Rohrbaugh, for the purpose of providing heat for ignition of the fuel mixture.

Claim 4 lacks an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and C-nox GmbH & Co. KG (hereafter C-nox)

Regarding claim 4, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said ignition source obtains heat from combustion of natural gas. C-nox teaches that it is known in the art to obtain heat from combustion of natural gas and a electrical resistance heater, to provide a temperature required for a firing space [see Para. 0048]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited ignition source in view of the teachings of C-nox, for the purpose of providing heat for ignition of the fuel mixture.

Claim 5 lacks an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and Hudson.

Regarding claim 5, Coffey in view of Mills discloses the apparatus of claim 1. Mills fails to explicitly disclose the apparatus, wherein said fuel mixture comprises lithium and lithium aluminum hydride. Hudson teaches that it is known in the art to include a catalyst comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited fuel mixture in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from a desired fuel mixture.

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Claims 17 and 18 lack an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and Layer et al. (hereafter Layer)

Regarding claim 17, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, further comprising a controller in communication with said voltage source. Layer teaches that it is known in the art to utilize a temperature controller for regulating heat produced by a resistive heater including a power or voltage source, to achieve a preselected temperature in a container for heating a fluid [see Paras. 0008, 0020, and 0021]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited controller in view of the teachings of Layer, for the purpose of regulating the generation of heat from a desired fuel mixture.

Regarding claim 18, Coffey in view of Mills discloses the apparatus of claim 17. Coffey fails to explicitly disclose the apparatus, wherein said controller is configured to cause vary said voltage in response to temperature of said fluid to be heated. Layer teaches that it is known in the art to utilize a temperature controller for regulating heat produced by a resistive heater including a power or voltage source, to achieve a preselected temperature in a container for heating a fluid [see Paras. 0008, 0020, and 0021]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited controller in view of the teachings of Layer, for the purpose of regulating the voltage supplied to the resistive heater and the generation of heat from a desired fuel mixture.

Claims 19-28 meet the criteria set out in PCT Article 33(2)-(3) because the prior art does not teach or fairly suggest certain subject matter in the claims, as follows:

Regarding claim 19, the prior art of record, individually or in combination, does not teach or fairly suggest an apparatus of claim 2, wherein said tank is configured for holding fluid to be heated, wherein said fuel wafer is configured to be in thermal communication with said fluid, wherein said resistor is configured to be coupled to a voltage source, wherein said apparatus further comprises a controller in communication with said voltage source, and a temperature sensor, wherein said fuel mixture comprises lithium, and lithium aluminum hydride, wherein said catalyst comprises a group 10 element, wherein said controller is configured to monitor a temperature from said temperature sensor, and, based at least in part on said temperature, to reinvigorate a reaction in said fuel mixture, wherein reinvigorating said reaction comprises varying a voltage of said voltage source.

Claims 20-28 depend from base claim 19, and therefore meet the criteria set out in PCT Article 33(2)-(3) for at least the same reasons as does base claim 19.

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The following prior art is made of record to support and further define the reasons for meeting the criteria set out in PCT Article 33(2)-(3) for base claim 19:

(i) Regarding claim 19, Coffey discloses an apparatus for heating fluid, said apparatus comprising a tank for holding fluid to be heated, and a fuel wafer in fluid communication with said fluid, said fuel wafer including a fuel mixture including reagents or reactant powders, and an ignition source in thermal communication with said fuel mixture and said catalyst, wherein the ignition source is selected from the group consisting of an electrical resistor [see Figs. 12, 17, and 20, and Paras. 0007, 0072, 0085 and 0090]. Mills teaches that it is known in the art to include fuel mixture comprising reagents and a catalyst in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. Layer teaches that it is known in the art to utilize a temperature controller for regulating heat produced by a resistive heater including a power or voltage source, to achieve a preselected temperature in a container for heating a fluid [see Paras. 0008, 0020, and 0021]. Hudson teaches that it is known in the art to include a catalyst comprising a group 10 element such as nickel and a reagent comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. Coffey does not teach, either alone or in combination with the prior art of record, the apparatus of claim 2, wherein said tank is configured for holding fluid to be heated, wherein said fuel wafer is configured to be in thermal communication with said fluid, wherein said resistor is configured to be coupled to a voltage source, wherein said apparatus further comprises a controller in communication with said voltage source, and a temperature sensor, wherein said fuel mixture comprises lithium, and lithium aluminum hydride, wherein said catalyst comprises a group 10 element, wherein said controller is configured to monitor a temperature from said temperature sensor, and, based at least in part on said temperature, to reinvigorate a reaction in said fuel mixture, wherein reinvigorating said reaction comprises varying a voltage of said voltage source.

Claims 1-36 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.