

## PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

# PCT

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To:  
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Date of mailing  
(day/month/year) **26 February 2018 (26.02.2018)**

Applicant's or agent's file reference  
16-1444-WO

**FOR FURTHER ACTION**

See paragraph 2 below

International application No.

**PCT/US2017/064074**

International filing date (day/month/year)

**30 November 2017 (30.11.2017)**

Priority date(day/month/year)

28 December 2016 (28.12.2016)

International Patent Classification (IPC) or both national classification and IPC

**F02G 1/043(2006.01)i, F02G 1/055(2006.01)i, F01K 27/02(2006.01)i**

Applicant

**X DEVELOPMENT LLC**

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.

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WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2017/064074

Box No. I 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 43bis.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 13ter.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 13ter.1(a)).
    - on paper or in the form of an image file (Rule 13ter.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:

**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

**PCT/US2017/064074**

**Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	<u>1-20</u>	YES
	Claims	<u>NONE</u>	NO
Inventive step (IS)	Claims	<u>NONE</u>	YES
	Claims	<u>1-20</u>	NO
Industrial applicability (IA)	Claims	<u>1-20</u>	YES
	Claims	<u>NONE</u>	NO

2. Citations and explanations :

Reference is made to the following document:

D1: US 2015-0260463 A1 (GIGAWATT DAY STORAGE SYSTEMS, INC.) 17 September 2015

1. Novelty and Inventive step

1.1 Independent Claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a thermal energy storage system comprising: a compressor (1); a recuperator (5); a hot side heat exchanger (2); a turbine (3); a cold side heat exchanger (4); and a working fluid (20) circulating in a closed cycle path through, in sequence, the compressor (1), the recuperator (5), the hot side heat exchanger (2), the turbine (3), the recuperator (5), and the cold side heat exchanger (4) (see paragraphs [0110], [0143] and figures 4A, 7B).

Claim 1 differs from D1 in that it comprises a cooling heat exchanger, wherein the cooling heat exchanger is configured to remove heat from a working fluid. However, this difference would be easily conceived from an additional heat exchanger (41), wherein the working fluid (20) can exchange heat with a heat sink (42) in the heat exchanger (41) in D1 (see paragraph [0210] and figure 15A). Accordingly, claim 1 would have been obvious over D1. Therefore, claim 1 does not involve an inventive step under PCT Article 33(3).

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1.2 Dependent Claims 2-8

1.2.1 Claim 2

The additional feature of claim 2 is identical to a cold side tank (9), a cold side tank (8) and a CTS medium (22) flowing from the cold side tank (9), through the cold side heat exchanger (4), and to the cold tank (8) in D1 (see figure 7B). Accordingly, claim 2 would have been obvious over D1. Therefore, claim 2 does not involve an inventive step under PCT Article 33(3).

1.2.2 Claim 3

The additional feature of claim 3 is identical to the feature of D1 in that the CTS medium (22) is hexane (see paragraph [0078]). Accordingly, claim 3 would have been obvious over D1. Therefore, claim 3 does not involve an inventive step under PCT Article 33(3).

1.2.3 Claim 4

The additional feature of claim 4 is identical to a hot side tank (6), a hot side tank (7) and an HTS medium (21) flowing from the hot side (6), through the hot side heat exchanger (2), and to the hot side tank (7) in D1 (see figure 7B). Accordingly, claim 4 would have been obvious over D1. Therefore, claim 4 does not involve an inventive step under PCT Article 33(3).

1.2.4 Claim 5

The additional feature of claim 5 is identical to the feature of D1 in that the HTS medium (21) is molten salt (see paragraph [0076]). Accordingly, claim 5 would have been obvious over D1. Therefore, claim 5 does not involve an inventive step under PCT Article 33(3).

1.2.5 Claim 6

The additional feature of claim 6 is characterized in that the cooling heat exchanger is a radiator, wherein the working fluid circulating through the cooling heat exchanger expels heat

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to air. This feature would be easily conceived from the disclosure of D1 considering that a radiator is operatively coupled to an apparatus to dissipate waste heat generated during operation of the apparatus (see claim 11). Accordingly, claim 6 would have been obvious over D1. Therefore, claim 6 does not involve an inventive step under PCT Article 33(3).

1.2.6 Claim 7

The additional feature of claim 7 is identical to the feature of D1 in that the heat exchanger (41) circulates a thermal fluid in thermal contact with a heat sink (42) (see paragraph [0207] and figure 15A). Accordingly, claim 7 would have been obvious over D1. Therefore, claim 7 does not involve an inventive step under PCT Article 33(3).

1.2.7 Claim 8

The additional feature of claim 8 is characterized in that a heat sink is a cooling tower. This feature is merely a variation of the heat sink (42) in D1 (see paragraph [0207] and figure 15A). Accordingly, claim 8 would have been obvious over D1. Therefore, claim 8 does not involve an inventive step under PCT Article 33(3).

1.3 Independent Claim 9

D1, which is considered to be the closest prior art to the subject matter of claim 9, discloses a thermal energy storage system comprising: a compressor (1); a recuperator (5); a hot side heat exchanger (2); a turbine (3); a cold side heat exchanger (4); a working fluid (20) circulating in a closed cycle path through, in sequence, the compressor (1), the recuperator (5), the hot side heat exchanger (2), the turbine (3), the recuperator (5), and the cold side heat exchanger (4); a cold side thermal storage medium (22); a cold side tank (8); a thermal bath (63); a cold side tank (9); and a flow path configured to flow CTS medium (22) from the cold side tank (9) to the cold side heat exchanger (4) and to the cold side tank (8) (see paragraphs [0110], [0143], [0184] and figures 4A, 7B, 9H).

Claim 9 differs from D1 in that it comprises an intermediate CTS tank and a second flow path configured to flow a CTS medium from the intermediate CTS tank, through the CTS heat exchanger, and to a second CTS tank. However, this difference would be easily conceived from

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the disclosure of D1 considering that an intermediate medium or fluid (62) may be used for exchanging heat between the working fluid (20) and the thermal bath (63) in the cold side heat exchanger (4) (see paragraph [0184] and figure 9H). Accordingly, claim 9 would have been obvious over D1. Therefore, claim 9 does not involve an inventive step under PCT Article 33(3).

1.4 Dependent Claims 10-15

1.4.1 Claim 10

The additional feature of claim 10 is identical to the feature of D1 in that the CTS medium (22) is hexane (see paragraph [0078]). Accordingly, claim 10 would have been obvious over D1. Therefore, claim 10 does not involve an inventive step under PCT Article 33(3).

1.4.2 Claim 11

The additional feature of claim 11 is identical to a hot side tank (6), a hot side tank (7) and an HTS medium (21) flowing from the hot side tank (6), through the hot side heat exchanger (2), and to the hot side tank (7) in D1 (see figure 7B). Accordingly, claim 11 would have been obvious over D1. Therefore, claim 11 does not involve an inventive step under PCT Article 33(3).

1.4.3 Claims 12 and 13

The additional features of claims 12 and 13 are characterized in that the CTS heat exchanger is a cooling tower (claim 12) or the CTS heat exchanger is a radiator, wherein the CTS medium flowing through the CTS heat exchanger expels heat to air (claim 13). These features are merely variations of the thermal bath (63) in D1 (see figure 9H). Accordingly, claims 12 and 13 would have been obvious over D1. Therefore, claims 12 and 13 do not involve an inventive step under PCT Article 33(3).

1.4.4 Claims 14 and 15

The additional features of claims 14 and 15 are characterized in that a third flow path is

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configured to flow CTS medium from the second CTS tank to the first flow path and inject CTS medium from the second CTS tank into the first flow path (claim 14), wherein the third flow path intersects the first flow path at a location intermediate to the first flow path entering the cold side heat exchanger and the first flow path exiting the heat exchanger (claim 15). These features are merely variations of the CTS flow path in D1 (see paragraph [0201] and figure 14A). Accordingly, claims 14 and 15 would have been obvious over D1. Therefore, claims 14 and 15 do not involve an inventive step under PCT Article 33(3).

1.5 Independent Claim 16

D1, which is considered to be the closest prior art to the subject matter of claim 16, discloses a method comprising the steps of: in a closed cycle system operating in a power generation mode, circulating a working fluid (20) through a closed cycle fluid path including, in sequence, a compressor (1), a recuperator (5), a hot side heat exchanger (2), a turbine (3), the recuperator (5) and a cold side heat exchanger (4); and flowing a cold side thermal storage medium (22) at a first variable flow rate from a cold side tank (9), through the cold side heat exchanger (4) and in thermal contact with the working fluid (20) to a cold side tank (8) (see paragraphs [0110], [0143], [0184] and figures 4A, 7B, 9H).

Claim 16 differs from D1 in that it comprises the step of flowing a CTS medium from an intermediate CTS tank, through a CTS heat exchanger, and to a second CTS tank, wherein the CTS heat exchanger is configured to remove heat from the CTS medium. However, this difference would be easily conceived from the disclosure of D1 considering that an intermediate medium or fluid (62) may be used for exchanging heat between the working fluid (20) and the thermal bath (63) in the cold side heat exchanger (4) (see paragraph [0184] and figure 9H). Accordingly, claim 16 would have been obvious over D1. Therefore, claim 16 does not involve an inventive step under PCT Article 33(3).

1.6 Dependent Claims 17-20

1.6.1 Claim 17

The additional feature of claim 17 is identical to the feature of D1 in that the heat engines may operate on a Brayton cycle (see paragraph [0070]). Accordingly, claim 17 would have

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been obvious over D1. Therefore, claim 17 does not involve an inventive step under PCT Article 33(3).

1.6.2 Claims 18-20

The additional features of claims 18-20 are characterized in the steps of: varying the first variable flow rate based on a temperature of the CTS medium (claim 18); flowing the CTS medium at a second variable flow rate from the second tank to the cold side heat exchanger (claim 19); and varying the second variable flow rate based on a temperature of the CTS medium (claim 20). These features would be easily conceived from the disclosure of D1 considering that flow rates of thermal storage media may be adjusted to accommodate the incorporation of additional heat sources (see paragraph [0194]). Accordingly, claims 18-20 would have been obvious over D1. Therefore, claims 18-20 do not involve an inventive step under PCT Article 33(3).

2. Industrial Applicability

Claims 1-20 are industrially applicable under PCT Article 33(4).