


PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P11694PC00		FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/EP2016/065310		International filing date (<i>day/month/year</i>) 30.06.2016	Priority date (<i>day/month/year</i>) 30.06.2015
International Patent Classification (IPC) or national classification and IPC INV. F03G7/06			
Applicant Exergyn Limited			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>5</u> sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (<i>sent to the applicant and to the International Bureau</i>) a total of <u>5</u> sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2).</p> <p><input type="checkbox"/> superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)).</p> <p>b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in the form of an Annex C/ST.25 text file, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3ter of Annex C of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input checked="" type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand 28.04.2017		Date of completion of this report 01.06.2017	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465		Authorized officer Giorgini, Gabriele Telephone No. +49 89 2399-7244	



Box No. I Basis of the report

1. With regard to the **language**, this report is based on
- 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 (under Rules 12.3(a) and 23.1(b))
 - publication of the international application (under Rule 12.4(a))
 - international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))
2. With regard to the **elements*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

Description, Pages

1-7 as originally filed

Claims, Numbers

1-6 filed in electronic form on 28-04-2017

Drawings, Sheets

1/3-3/3 as originally filed

- a sequence listing - see Supplemental Box Relating to Sequence Listing.
3. The amendments have resulted in the cancellation of:
- the description, pages
 - the claims, Nos.
 - the drawings, sheets/figs
 - the sequence listing (*specify*):
4. This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
- the description, pages
 - the claims, Nos.
 - the drawings, sheets/figs
 - the sequence listing (*specify*):
5. This report has been established:
- taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
 - without taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

6. With regard to top-up searches (Rules 66.1 *ter* and 70.2(f)):
- A top-up search was carried out by this Authority on 16.05.2017 (all discovered documents are listed in the Supplemental Box Relating to Top-up Search).
 - Additional relevant documents have been discovered during the top-up search.
 - No top-up search was carried out by this Authority because it would serve no useful purpose.
7. Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

* *If item 4 applies, some or all of those sheets may be marked "superseded".*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>1-6</u>
	No: Claims	
Inventive step (IS)	Yes: Claims	<u>1-6</u>
	No: Claims	
Industrial applicability (IA)	Yes: Claims	<u>1-6</u>
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

POINT V

a) Closest prior art

D1: DE 10 2012 2092396, which discloses an energy recovery device (see paragraphs 5, 31, 42 in combination with fig. 1, 5 and 6) comprising a plurality of Shape-Memory Alloy elements 122, 162 (see paragraph 108) arranged as a plurality of wires positioned substantially parallel with each other to define a core wherein the wires are selected to have different dimensions (see paragraph 108) and the plurality of wires are activated at substantially the same time in response to a temperature change (see paragraph 103).

b) Novelty (Art. 33(2) PCT)

The subject-matter of claim 1 differentiate from the system of D1 in that the wires positioned to centre of the core have a smaller diameter than the wires positioned near the outside of the core.

The subject-matter of claim 1 is therefore new (Art. 33(2) PCT).

c) Inventive step (Art. 33(3) PCT)

The problem the invention is intended to solve can be seen in rendering the heat transfer in the wires as homogeneous as possible.

The wires of D1 (see fig. 1, 5 and 6) are disclosed with the same diameter as the heating of the SMA elements is achieved directly through Joule effect.

For this reason the skilled person would consider a modification of the energy recovery device of D1 in the direction of claim 1 as unnecessary and unmotivated, and therefore the skilled person would not consider said opportunity.

Furthermore there are no further hints, neither in the other cited documents which would prompt the skilled person to adapt or modify the device of D1 to arrive at the subject-matter of claim 1.

The subject-matter of claim 1 is therefore inventive (Art. 33(3) PCT).

Claims 2 to 5 are dependent on claim 1 and therefore also considered novel and inventive.

Method claim 6 specifies in method terms the same inventive concept of claim 1 and therefore it is also considered as novel and inventive (Art. 33(2) and (3) PCT).

POINT VII

The following objections are raised:

Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor are these documents identified therein.

28 April 2017

European Patent Office
D-80298 Munich
Germany

Our Ref: P11694PC00

BY CMS ONLY

PCT Patent Application No. PCT/EP2016/065310
In the name of Exergyn Ltd.
"SMA Bundle Wire Optimisation in an Energy Recovery Device"

Dear Sirs

Enclosed please find:

1. Demand for Preliminary Examination;
2. Article 34 claims in tracked and change accepted format; and
3. Payment of the Handling and Preliminary Examination fees (€2,113) has been made electronically from our Deposit Account Number 28060020.

Claims & Clarity

Applicant respectfully submits amended Claim 1 to include the features of Claim 2 and amended to clarify the function of the the wires which are positioned towards the centre of the core have a smaller diameter than wires positioned near the outside of the core. Claims 1 to 11 meet the requirements of Article 33 PCT for the following reasons:

Novelty of Claim 1

As Claim 1 now includes the features of Claim 2 and the function of the the function of the the wires which are positioned towards the centre of the core have a smaller diameter than wires positioned near the outside of the core. Applicant respectfully submits that Claim 1, and related dependent claims, are clearly Novel over DE 10 2012 202396 or EP1 130 257 or US4,306 415, hereinafter referred to as D1, D2 and D3 respectively.

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Inventiveness of Claim 1

In the context of the present invention a plurality of Shape Memory Alloy (SMAs) or Negative Thermal Expansion (NTE) elements are arranged as a plurality of wires positioned substantially parallel with each other to define a core that can be used in an energy recovery device.

It is desirable to translate the contraction of the SMA or NTE material into a mechanical force in an efficient manner by passing hot/cold fluid over the wires to generate mechanical force that can be subsequently harnessed into energy.

The applicants discovered an important aspect of the system operation is the ability to bundle a large number of the NiTi elements at both ends such that a reliable assembly is created, enabling high-force, low displacement work to be performed for a maximum number of working cycles. It is not a trivial task and generally is complicated and involves significant energy losses.

A problem with bundling or arranging the wires close together is that uneven heating of wires in the core results in stresses within the wires that shorten their fatigue life. In other words due to poor heat transfer from the fluid to the wires some wires are heated before others causing weaknesses and failure points in the wires. Extensive laboratory testing found that the core of wires simply broke down due to ineffective heat transfer to all of the wires at substantially the same time.

Present amended Claim 1 overcomes this problem by providing the wires positioned towards the centre of the core have a smaller diameter than wires positioned near the outside of the core such the plurality of wires are activated at substantially the same time in response to a temperature change.

Applicant respectfully submits the operation is totally different and the configuration of the engine core, comprising a plurality of elongated wires, with a different diameter wires to ensure all the wires change state at the same time, is a very different device to what is disclosed by D1, as well as D2 to D3, cited in the PCT search report. The core described in Claim 1 provides an elegant solution ensuring that even heat transfer is achieved to all wires at the same time to ensure even activation of the wires while enabling high-force, low displacement work to be performed for a maximum number of working cycles. The device shown in D1 is a totally different energy recovery device to Claim 1 and the skilled person would not contemplate the teaching of present amended Claim 1 from a reading of D1.

Moreover, for reasons outlined above there is nothing to suggest or infer from D1 (or other prior art cited) to provide a solution for energy recovery using the engine core to ensure a reliable even heat transfer of the SMA elements as outlined in Claim 1 which overcomes present technical problems in the art. Therefore Claim 1, and the associated dependent Claims, Claims 5 and 6 meet the requirements of Article 33(3) PCT.

Formal Requirements

Amended claim 1 is drafted in the two part form. Applicant respectfully submits the remaining formal requirements are held in abeyance until the PCT application enters into the various national/regional phases.

Conclusion

The Applicant respectfully requests that the Examiner reconsider the claims and arguments outlined above, and issue a positive Preliminary Examination Report.

Finally, should the Examiner deem it appropriate to maintain any substantive objections against the amended Claims, the Applicant hereby requests a personal interview with the Examiner prior to the issuance of the IPER.

Applicant looks forward to a favorable response in due course.

Yours faithfully,

A handwritten signature in cursive script that reads "Michael Lucey".

Michael Lucey
Professional Representative before the EPO
PURDYLUCEY

Claims

1. An energy recovery device comprising a plurality of Shape-Memory Alloy (SMAs) or Negative Thermal Expansion (NTE) elements arranged as a plurality of wires positioned substantially parallel with each other to define a core characterised in that the wires are selected to have different dimensions and the plurality of wires are activated at substantially the same time in response to a temperature change such that the wires positioned towards the centre of the core have a smaller diameter than wires positioned near the outside of the core.
2. The energy recovery device as claimed in claim 1 wherein the wire diameters are selected to match the characteristics of a fluid flow at any point in the core and take account of the impact of the flow with other wires and the loss in energy of the flow as it penetrates the bundle, and an even activation time can be achieved for the plurality of wires.
3. The energy recovery device as claimed in any preceding claim wherein at least one of the wires is tapered at one end.
4. The energy recovery device as claimed in any preceding claim wherein activation of at least one wire comprises a transformation from a martensite to an austenite state.
5. A core for use in an energy recovery device, said core comprising a plurality of wires positioned substantially parallel with each other and wherein the wires are selected to have different dimensions and the plurality of wires are activated at substantially the same time in response to a temperature change and the wires positioned towards the centre of the core have a smaller diameter than wires positioned near the outside of the core.
6. A method of making an energy recovery device comprising a plurality of Shape-Memory Alloy (SMAs) or Negative Thermal Expansion (NTE)

elements arranged as a plurality of wires positioned substantially parallel with each other to define a core comprising the step of selecting a plurality of wires with different dimensions and positioning the plurality of wires so that they are activated at substantially the same time in response to a
5 temperature change and positioned the wires positioned towards the centre of the core with a smaller diameter than wires positioned near the outside of the core.