TRANSLATION

FEDERAL SERVICE ON INDUSTRIAL PROPERTY, PATENTS AND TRADE MARKS **(ROSPATENT)**

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In correspondence, please refer to the application number
and report a receipt date of this communication

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DECISION ON GRANT
A PATENT FOR INVENTION

(21) Application No. **2014117676/07(028083)** (22) Application filing date **02.10.2012**

As a result of the substantive examination of the application for invention, it has been stated that

the claimed group of inventions
relates to the objects of patent rights and complies with the patentability conditions stipulated by the Civil Code of the Russian Federation, the essence of the claimed invention (inventions) is fully disclosed in the application materials such that it is possible to implement the claimed invention (inventions), and, in view of this, a decision to grant a patent for the invention has been taken.

A Report on Examination Results is enclosed.

Enclosure: on 6 sheets in 1 copy.

Head *Signature* L. L. Kiryi

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REPORT ON EXAMINATION RESULTS

(21) Application № **2014117676/07(028083)** (22) Date of filing the application **October 2, 2012**
(24) Date from which industrial property rights may have effect **October 2, 2012**
(85) Date of commencement of the national phase **May 05, 2014**

PRIORITY IS FIXED ON DATE

☐ (22) Date of filing the application

☐ (23) Date of filing of additional materials of to the earlier application №

☐ (62) ☐ priority date of the application № of from which the present application has been divided up
☐ filing date of the application № of from which the present application has been divided up

☐ (66) Filing date of the earlier application №

☒ (30) Data relating to priority under the Paris Convention

(31) Number assigned to priority application	(32) Date of filing priority application	(33) Country code	Claim
13/251,717	**October 3, 2011**	**US**	

(86) PCT Application number and date **PCT/US2012/058411** of **October 2, 2012**.
(87) PCT Publication number and date **WO 2013/077941 A3** of **30 May 2013**.

(72) Inventors: **MASSIE, Mark, US;**
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(73) Assignee: **TRANSATOMIC POWER CORPORATION, US**

(51) IPC **G21C 1/22** (2006.01)**,**
G21C 1/06 (2006.01).

(54) Title **NUCLEAR REACTORS AND RELATED METHODS AND APPARATUS**

The Examination department basing on the results of substantive examination of the patent application, conducted according to Article 1386 and Article 1387 paragraph 1 of the Civil Code of the Russian Federation, consummated by the Federal Low as of December 18 2006 No. 230 FL, in respect to

☒ claims amended by the applicant

has revealed the concordance of the claimed invention to the requirements of patentability set forth by Articles 1349 and 1350 of the Civil Code of the Russian Federation, Fourth Part, and decided to grant the Patent of the Russian Federation.

The following set of claims is enclosed on pages 3 – 5.

(21) **2014117676/07**

(51) IPC
G21C 1/22 (2006.01)**,**
G21C 1/06 (2006.01).

(57)

1. A nuclear reactor comprising:

a fissionable material,

a molten salt, and

a moderator material comprising a zirconium hydride (ZrHx) in which x is between 1 and 4.

2. The reactor of claim 1, in which the moderator material comprises $ZrH_{1.6}$, particularly wherein the zirconium hydride is in a crystalline form.

3. The reactor of claim 1, in which the moderator material further comprises a form of lithium hydride.

4. The reactor of claim 1, in which the moderator material further comprises a form of yttrium hydride, particularly wherein the form of yttrium hydride comprises yttrium(II) hydride (YH_2), yttrium(III) hydride (YH_3), or a combination thereof.

5. The reactor of claim 1, in which the moderator material further comprises a form of zirconium deuteride.

6. The reactor of claim 1, in which the fissionable material comprises natural uranium, enriched uranium, depleted uranium, plutonium or uranium from spent nuclear fuel, plutonium down-blended from excess nuclear weapons materials, thorium and a fissile material, transuranic material, or a combination of any two or more of them; particularly in which the fissionable material comprises a fissile-to-fertile ratio in the range of 0.01-0.25.

7. The reactor of claim 1, in which the molten salt comprises lithium fluoride, particularly in which the lithium fluoride is enriched in its concentration of Li-7.

8. The reactor of claim 1, in which solubility of actinides in the molten salt is sufficient to permit the fissionable material to become critical**,** particularly in which the solubility of actinides in the molten salt is at least 0.3 mol. %**,** more particularly, more particularly at least 12 mol. %**,** or more particularly at least 20 mol. %**.**

9. A method of operating a nuclear reactor, the method comprising:

in a nuclear reactor, flowing fissionable material and a molten salt past a moderator material that comprises a zirconium hydride (ZrHx) in which x is between 1 and 4.

10. The method of claim 9, in which flowing the fissionable material and the molten salt past the moderator material comprises flowing a fuel-salt mixture through a reactor core, the fuel-salt mixture comprising the fissionable material and the molten salt.

11. The method of claim 9, in which the fissionable material comprises an entire spent nuclear fuel actinide vector.

12. The method of claim 9, in which the fissionable material comprises portions but not all of the actinides of spent nuclear fuel.

13. The method of claim 9, in which the fissionable material comprises unprocessed spent nuclear fuel.

14. A nuclear reactor comprising:

a primary loop comprising:

a reactor core comprising a moderator structure comprising a moderator material that comprises a zirconium hydride (ZrHx) in which x is between 1 and 4, and

a pathway along which a fissionable material and molten salt can flow from an exit end of the moderator structure in a loop to an entrance end of the moderator structure.

15. The reactor of claim 14, comprising a secondary loop and a heat exchanger to exchange heat between the primary loop and the secondary loop.

16. The reactor of claim 14, comprising an intermediate loop, a secondary loop, a heat exchanger to exchange heat between the primary loop and the intermediate loop, and an additional heat exchanger to exchange heat between the intermediate loop and the secondary loop.

17. The reactor of claim 14 also comprising a freeze valve, particularly wherein the freeze valve controls flow between the primary loop and an auxiliary containment subsystem, more particularly between the primary loop and a passively cooled storage tank of the auxiliary containment subsystem.

(56) CH 596638 A5, 15.03.1978;
UA 56382 U, 10.01.2011;
SU 786619 A1, 15.08.1991;
US 6,707,871 B1, 16.03.2004;
US 3,277,565 A1, 11.10.1966;
RU 2 122 245 C1, 20.11.1998;
WO 2010/129836 A1, 11.11.2010;
V. L. BLINKIN et al. «Molten Salt Reactors”, Moscow, Atomizdat 1978, p. 18, 25, 72;
RU 2 400 836 C1, 27.09.2010.

In publishing information on issue of the patent the description of the invention will be used as originally filed.

In publishing information on issue of the patent the drawings will be used as originally filed.

Enclosure: Abstract amended by the examiner (one page).

Leading official patent examiner K. V. Raskovalov

Enclosure

To be published with fig. 1 Application 2014117676/28

(54) **NUCLEAR REACTORS AND RELATED METHODS AND APPARATUS**

Abstract

(57) The present invention relates to arrangement of a nuclear reactor. A nuclear reactor comprises a combination of a fissionable material, a molten salt, and a moderator material comprising two or more hydrides, one or more deuterides and a combination of two or more of them. The fissionable material comprises natural uranium, enriched uranium, depleted uranium, plutonium or uranium from spent nuclear fuel, plutonium down-blended from excess nuclear weapons materials, thorium and a fissile material, transuranic material, or a combination of any two or more of them. The technical result is to enable effective management of the spectral characteristics of the reactor and the reactor criticality.
3 independent claimы, 14 dependent claims, 3 tables, 11 drawings.

СОЮЗ СОВЕТСКИХ
СОЦИАЛИСТИЧЕСКИХ
РЕСПУБЛИК

(19) SU (11) 786619 A1

(51)5 G 21 C 1/28

ГОСУДАРСТВЕННЫЙ КОМИТЕТ
ПО ИЗОБРЕТЕНИЯМ И ОТКРЫТИЯМ
ПРИ ГКНТ СССР

ОПИСАНИЕ ИЗОБРЕТЕНИЯ

К АВТОРСКОМУ СВИДЕТЕЛЬСТВУ

1

(21) 2796179/25
(22) 16.07.79
(46) 15.08.91. Бюл. № 30
(72) В.Ф.Колесов и А.А.Малинкин
(53) 621.039.555(088.8)

(56) Дементьев Б.А. Кинетика и регулирование ядерных реакторов. Атомиздат, М., 1973, стр. 6.

Дубовский Б.Г. Секционированные реакторные системы. Атомная энергия, том 7, вып. 5, 1959 г., стр. 456.

2

(54)(57) ДВУХКАСКАДНЫЙ УМНОЖИТЕЛЬ НЕЙТРОНОВ, содержащий две активные зоны, выполненные из делящегося материала, разделенные нейтронным вентилем, содержащим замедлитель, о т л и ч а ю щ и й с я тем, что, с целью уменьшения длительности нейтронных переходных процессов, первая активная зона выполнена из порогового делящегося материала, а вторая - из непорогового, а замедлитель выполнен из материала с высоким атомным весом.

Изобретение относится к области импульсных источников нейтронного и гамма-излучений, широко применяемых в физическом эксперименте.

Известны умножители нейтронов, состоящие из реактора, с управляемой кретичностью, и источника подсветки нейтронами. Основным недостатком этого известного устройства являются низкие потоки нейтронов в импульсе.

Известны многокаскадные умножители нейтронов, перспективные для осуществления импульсного режима с получением высоких потоков нейтронов в импульсе.

Работа известных многокаскадных умножителей нейтронов основана на использовании перепадов в коэффициентах прохождения нейтронов из одной активной зоны (АЗ) в другую (т.е. в прямом и обратном направлениях), обеспечиваемого так называемыми нейтронными вентилями, пропускающими нейтроны преимущественно только в одном направлении, располагаемыми на границе раздела между критическим реактором - источником подсветки нейтронами и первой подкритической сборкой, а также на границах раздела подкритических сборок - умножителей нейтронов.

Наиболее близким к предлагаемому изобретению является двухкаскадный умножитель нейтронов, содержащий две активные зоны, выполненные из делящегося материала и разделенные нейтронным вентилем, содержащим замедлитель, слой кадмия и слой урана 235, пропускающим нейтронами преимущественно в направлении от урана к замедлителю.

Основной недостаток - низкая эффективность используемых вентилей, при практически реализуемых толщинах в лучшем случае пропускающих в оптимальном направлении лишь в пять-десять раз больше нейтронов, чем в противоположном направлении, и необходимость замедления нейтронов, перемещающихся из одной АЗ в другую, до промежуточных и тепловых энергий, что увеличи-

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(51) Int. Cl.[6] **G 21 C 7/10**

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FOR PATENTS AND TRADEMARKS

(12) ABSTRACT OF INVENTION

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(46) Date of publication: 20.11.1998

(71) Applicant:
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RU 2122245 C1

(54) FAST REACTOR CONTROL ROD

(57) Abstract:
FIELD: nuclear power engineering; nuclear power plants incorporating fast breeder reactors using liquid-metal coolant (sodium). SUBSTANCE: control rod whose absorbing part has neutron moderator and absorber is provided, in addition, with one more neutron moderator placed along rod axis beyond its absorbing part so that it abuts against one of ends of absorbing part. EFFECT: improved operating safety of reactors. 2 cl, 5 dwg

RU 2122245 C1

RUSSIAN FEDERATION

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PATENTS AND TRADEMARKS

(19) **RU** (11) **2 400 836** (13) **C1**

(51) Int. Cl.
G21C 5/12 (2006.01)

(12) ABSTRACT OF INVENTION

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(24) Effective date for property rights:
10.06.2009

(45) Date of publication: 27.09.2010 Bull. 27

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(54) NEUTRON MODERATOR ON BASIS OF ZIRCONIUM HYDRIDE

(57) Abstract:

FIELD: power industry.

SUBSTANCE: to material on the basis of zirconium hydride, which contains aluminium, there added in addition is nickel at the following component ratio, wt %: aluminium 0.1-0.3, nickel 0.5-1.0, zirconium hydride - the rest.

EFFECT: development of neutron moderator containing zirconium hydride as the base, which would have higher corrosion resistance and would retain hydrogen at high temperatures as much as possible.

1 cl, 3 dwg

RU 2400836 C1

RU 2400836 C1

UA 56382 (U)

PERHYDROUS NEUTRON MODERATOR OF ZIRCONIUM HYDRIDE

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Applicant(s):	FRANTSEVYCH INST OF PROBLEMS OF MATERIAL SCIENCE OF THE NAS OF UKRAINE [UA] + (FRANTSEVYCH INSTITUTE OF PROBLEMS OF MATERIAL SCIENCE OF THE NAS OF UKRAINE)
Classification:	**- international:** ***C01B6/00*** **- cooperative:**
Application number:	UA20100008449U 20100706
Priority number(s):	UA20100008449U 20100706

Abstract

A perhydrous neutron moderator of zirconium hydride, composition of which is determined by the following formula of $ZrH_{x>2}$, and weight coefficient of neutron removal is in 1.2-1.23 times greater.