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(54) **TANK FOR STORING PETROLEUM PRODUCTS AND FLOATING ELEMENT FOR SAID TANK**

(57) Present invention relates to the field of a storage tank design and can be used in the construction of tanks for storing light ends and, preferably, for storing gasoline. The claimed tank for storing petroleum products consists of a body, a roof and a floating protective cover comprised of a plurality of floating elements in the form of solids of revolution having the same shape. In the tank, a portion of the floating elements of the protective cover is situated below the surface of the liquid, and a portion is situated in the gas space of the tank. The distinguishing feature of the proposed invention is the floating elements, which differ from one another in shape and size by not more than 5%. Furthermore, the floating elements that make up the floating protective cover have a centre of flotation that is offset from their geometric centre. All of the elements of the protective cover are made of non-sparking metal. The technical result of the invention is that of reducing the rate of evaporation of the liquid and the concentration of vapors, suppressing the process of combustion and preventing the possibility of electrostatic buildup and spark discharge between the floating elements.

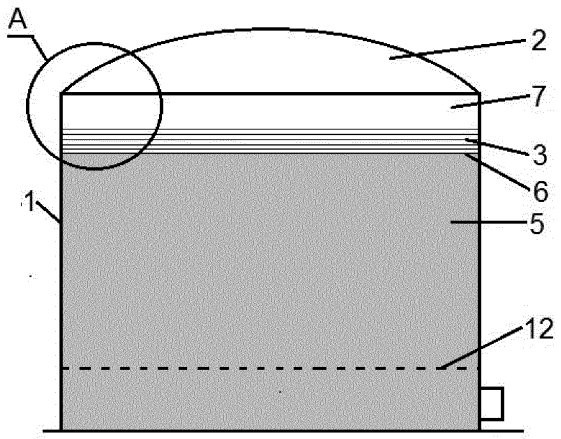

Fig. 1

EP 3 165 479 A1

Description

[0001] The present invention refers to a tank construction and may be used for the construction of storage tanks for light ends of petroleum products and preferably for gasoline storage.

[0002] In petroleum product storage tanks currently operated for storage of petroleum products without a floating cover or pontoons, the intensive evaporation of petroleum products occurs on a liquid surface, which results in the formation of explosive and flammable vapor mixture in the gas space of a tank. Even with the use of modem lighting protection systems, we cannot avoid lighting striking to the tank. If lighting strikes any tanks filled with petroleum products, explosions and fires occur, which lead not only to significant losses but also result in injuries and death of people.

[0003] There are known methods of production of single-disc floating covers with a circular pontoon, radial and circular floats or a ring pontoon and point floats, in which a central part of the floating covers is delivered to a construction site as individual sheets, ring pontoon, radial, ring buoys are delivered as individual elements, respectively: hermetically sealed units (compartments), profile or box girders, bottomless boxes. Radial, circular, point floats are located evenly over the entire cover area /RU2200120, B65D88/34, 10.03.2003; GB1191461A, B65D88/34, 13.05.1970, RU2127216 C1, B65D88/34, 10.03.1999, RU2163559 C1, B65D88/34, 27.02.2001/. On the racks above the bottom, a frame and floating cover pontoons are collected. By the frame layers of the central part are spread, welded together. On the spreading central part of the floating cover, radial and circular or point floats are welded. The finished central part of the floating cover is welded to the pontoon ring.

[0004] The main disadvantages of such covers are significant labor intensity of the construction, low portability and, moreover, large metal intensity. In tanks using such pontoons, the problem of formation of explosive and flammable vapor mixture is significantly reduced but also remains. In such tanks in the event of lighting or the discharge-load of petroleum products, the pontoon may be skewed within the tank, and it stops to perform its protective functions (so called rigid pontoons).

[0005] Invention /EP 2530032 A1, B65D88/34, 01.06.2012/ includes a cover, which consists of independent flexible compartments in which spherical bodies are located. The specified spherical bodies may have a different diameter to overlap densely a liquid margin by evaporation to the gas space of a tank. However, as practice shows spherical bodies with a lower diameter due to gravity action, as well present vibrations, always drop below the bodies with a large diameter and do not overlap the space between the bodies with a big diameter. Moreover, by chaotic filling of compartments with the bodies of various diameters, they would not form an ordered structure with the minimum size of an empty cell formed by the surfaces of the spherical bodies. But perforated cover compartments will decrease but not prevent liquid evaporation. Moreover, according to our studies, not only overlapping of liquid surface by the cover, which is located in the plane of a liquid surface, is of great importance, but also an overlap in the gas space above the liquid surface plays its role. At that in case of any collapsing of constructions into the liquid, for example, the elements of automatic fire extinguishing systems, what most likely occurs in explosions in the gas space of the tank, for example, with lighting strike, such cover will be submerged and stop playing protective role in the reduction of evaporation to the tank gas space combusted.

[0006] There is known the invention /US12533218, B65D88/34, 31.07.2008/ that represents a floating barrier to reduce evaporation of liquid product, which contains floating elements, which have a cross-sectional polyhedron form. This invention like the previously described one solves the problems of reduced evaporation, but does not solve the problem of combustion processes phlegmatization in the possible combustion of liquid and air mixture. In the specified invention, the problem of liquid surface overlapping on the tank walls is not also solved. On tank walls the increased evaporation of liquid product will occur, and hazardous liquid and air mixture will be collected in the gas space of the tank. Moreover, by chaotic filling of the tank with the floating elements specified in the invention, it is rather highly probable that the correct order of dense element installation "brink to the brink" will be impaired that inevitably will result in the increase of liquid evaporation rate.

[0007] Invention /US8616398 B2, B65D 90/22, 25.09.2012/ is the closest to the declared invention in which a floating barrier for the prevention of liquid evaporation is made with the set of floating bodies. But as in the invention /EP 2530032 A1, B65D88/34, 01.06.2012/, spherical bodies with a lower diameter, due to gravity action and vibrations, always drop below the bodies with a large diameter and do not overlap space between the bodies with a large diameter. As well by chaotic tank filling with the bodies of various diameters, they would not form an ordered structure with the minimum size of an empty cell formed by the surfaces of spherical bodies. But perforated cover compartments will decrease but not prevent liquid evaporation. Moreover, according to our studies, not only overlapping of liquid surface by the cover, which is located in the plane of a liquid surface, is of great importance but also an overlap in the gas space above the liquid surface plays the role. At that in case of any collapsing of constructions into the liquid, for example, the elements of automatic fire extinguishing systems, which most likely occurs in explosions in the gas space of the tank, for example, with lighting strike or static discharge, even preliminarily ordered installation of spherical bodies of various diameters will be impaired. Besides, in liquid discharge - loading to the tank, the spherical bodies will be shifted with respect to each other, rotated in respect of geometrical axis, what results in the adherence of flammable liquid to their surface and in-

creased evaporation. Moreover, the wall multi-layemess of the spheroid bodes declared in the invention /US8616398 B2, B65D 90/22, 25.09.2012/, with the use of various plastics and resins even with the applied antistatic coating may not completely prevent the accumulation of static electricity and the occurrence of discharge, which may cause ignition or explosion of vapor-air mixture. It is confirmed with the introduction of the appropriate amendments to the regulatory documents concerning prohibition to use plastic and other polymeric products for tanks and other tanks for petroleum products.

[0008] Therefore, the goal of the invention is to make the tank for the storage of petroleum products devoid of the disadvantages. The technical result is the following:

1) decrease of vapor mixture volume, which is formed with the evaporation of petroleum products, i.e. the decrease of liquid vapor concentration in the gas space of the tank;
2) provision of combustion process phlegmatization in the event of fire, lighting strike;
3) prevention of the possible accumulation of static discharge and occurrence of spark discharge between the floating bodies.

[0009] To solve the assigned task, as well to achieve the declared technical result, the petroleum product storage tank is offered, which consists of a body, a shell and a floating protective coating from numerous floating elements. The floating elements are made as rotation bodies of the same shape. Some part of the floating elements in the tank is located below a liquid surface, and some of them - in the tank gas space. The distinctive feature of the proposed invention is that the floating elements, which differ from each other in size for more than 5%. And the floating elements from which the floating protective coating is made have the flotation center offset from their geometric centre. All elements of the protective coating are made of non-sparkling metal.

[0010] It is also proposed to locate the floating elements in the gas space forming not more than four layers.

[0011] It is also proposed to locate the floating elements within a liquid forming not less than one and a half layers.

[0012] As well in the upper part of the tank, a grid with a cell less than the floating element diameter may be installed.

[0013] In the upper part of the tank, internal collaring may be also made.

[0014] In the lower part of the tank above a liquid discharge-load level, a grid with a cell smaller than the floating element diameter may be installed.

[0015] A floating element constituting a floating protective coating may be made of aluminum or its alloy.

[0016] A floating element may be made with a ceramic coating of aluminum oxide or stainless steel.

[0017] Hydrophobic coating may be applied to a floating element surface.

[0018] It is preferable that the ratio of a maximum diameter of a rotation body to its wall thickness is at least 60.

[0019] It is also proposed to make a floating element with the minimum diameter not less than 10 mm.

[0020] It is also proposed to make a floating element with the maximum diameter not more than 60 mm.

[0021] It is also proposed to make a floating element in a spheroid, ellipsoid or egg-shaped form.

[0022] The invention essence is clarified by drawings where

on fig.1, the general appearance of a covered tank is provided; where it is denoted: 1 - the tank, 2 - the tank cover, 3 - the floating protective coating consisting of numerous floating elements 4, 5 - the liquid (petroleum products), 6 - the liquid surface, 7 - the gas space, 8 - the grid, 9 - the collaring, 12 - the lower grid.

on fig.2 and fig.3 - section A of fig. 1;

on fig.4,5,6,7 - cross section of some possible forms of the floating elements; where it is denoted: 10 - the flotation center of a floating element, 11 - the geometric center of the floating element 4.

on fig.8- the flow charts of liquid evaporation rate in the tank are provided depending on its configuration: 13 - a curve for a tank without floating elements, 14 - a curve for a rigid pontoon tank, 15 - a curve for a tank with a floating protective coating from numerous floating elements.

[0023] The petroleum product storage tank 1 contains a cover 2, a floating protective coating 3 consisting of numerous floating elements 4 some of which are located in liquid 5, i.e. below liquid surface 6, and some of them above liquid surface 6, i.e. in gas space 7 (fig.1). In the upper part of the tank, a grid 8 (fig.2) or a collaring 9 (fig.3) are installed. Flotation center 10 of the floating elements 4 is offset from their geometric centre 11 (fig.4, 5, 6, 7). In the lower part of the tank above a drainage-load level, the upper grid 12 is made with a perforation cell smaller than the floating element diameter 4.

[0024] The tank 1 with the cover 2 and the floating protective coating 3 acts in the following way.

[0025] When the floating elements 4 are filled in to the tank 1 with the liquid 5 (petroleum products), as well when the liquid 5 is loaded and discharged, they, being chaotically distributed in the tank, are placed in several layers forming the floating protective coating 3 with dense packing.

[0026] In the event of oscillation of liquid surface 6 in loads and discharges or explosion, the floating protective coating 3 consisting of the numerous floating elements 4 as rotation bodies of the same shape functions by the principle of tank duckweed. In the event of possible lighting strike or collapse of the cover constructions 2 within the tank 1, the floating elements 4 may diverge, even fly apart within the tank 1. But then chaotically returning, they are placed to the structure with dense packaging (floating protective coating 3) thereby they extinguish evaporation and evolving fire locus, as well significantly

phlegmatize combustion process. To prevent the discharge of the floating elements 4 beyond the tank 1 in the event of explosion, in its upper part, the grid 8 or the collaring 9 are installed. The grid 8 has a cell smaller than the floating element diameter 4. The collaring 9 is installed as it is shown on fig.3, by the periphery of the upper part of the tank 1. It allows to localize and extinguish fire quickly and with the lack of risk of new explosions. To reduce the risk of penetration of the floating elements to drainage holes, in the lower part of the tank above liquid discharge -load, the grid 5 is made with a perforation cell smaller than a floating element diameter.

[0027] To reduce the concentration of liquid vapors in the gas space 7 of the tank 1 and provide phlegmatization of combustion process as the protective coating 3, the floating elements 4 are used which are made as rotation bodies, with the flotation center 10 offset from their geometric centre 11. E.g., as fig.4, 5, 6, 7 show, the floating element 4 may have a spherical, ellipsoid or egg-shaped form. Further considerations would be made in relation to the floating elements 4 having spherical form. However, it should be understood that such considerations also cover other rotation bodies. With the tank discharge and loading, the spherical floating elements 4 may touching each other turn about its geometrical center and touching the liquid 5 have a liquid film on its surface. The film may evaporate and vapors will penetrate to the gas space of the tank 7. To prevent this the spherical floating elements 4 are made so that their gravity center 10 is offset from their geometric centre 11 (fig.4-8). Hereby the spherical floating elements 4 will be constantly oriented in relation to the liquid surface 6 and in the event of the tank discharge-load may only fluctuate slightly in relation to their position. So a dry surface of the spherical floating element 4 will not be immersed to the liquid 5, and, respectively, have a liquid film. Moreover, hydrophobic coating may be applied to the surface of the floating element 4, which prevents a capillary effect. It will significantly reduce evaporation.

[0028] To prevent static electricity and possible spark discharge in the mass of the spherical floating elements 4, these elements should be made from non-sparkling metal, mainly from aluminum or its alloys. In this case, the necessary buoyancy of the elements 4 of the floating protective coating 3 may be provided. The criterion for selection of the floating element size 4 is the ratio:

$$n=D/t,$$

where D - the external diameter of the spherical floating element 4,

t - wall width of the spherical floating element 4.

[0029] The ratio of the floating element diameter n D to its wall thickness t should be at least 60. The preferred ratio is n=80...110. The larger ratio is undesirable as the floating wall element 4 will be too thin and not resistant to mechanic exposures. For the same reasons, the minimum diameter of the floating diameter D should be at least 10 mm. The maximum diameter of the floating element D should be not more than 60 mm. In this case the size of a cell formed by the surfaces of the floating elements 4, densely located will be less than the critical value, i.e. sufficient to break a chain reaction (explosion) of stoichiometric petroleum product and air mixture (see Semenov N.N., Chain reactions, M., Nauka, 1986). In other words, vapor -air mixture within such a cell will not explode being exposed to any ignition source (static electricity spark, lightning strike, open fire exposure, etc.).

[0030] Our studies have shown that a minimum number of layers of the floating elements 4 located in gas space to reduce the dramatically flammable liquid evaporation 5 and, respectively, entry of liquid vapors to the gas space 7 of the tank 1 should be at least four. Hereby combustion in the gas space 7 of the tank 1, even if it occurs for any reasons, would be phlegmatic. It is explained by the fact that the liquid evaporation rate 5 would be minimized due to overlapping of the liquid surface 6 and the gas space 7 above the surface 6 with several layers of the floating elements 4.

[0031] Our calculations and tests have shown that the number of layers of the floating elements 4 located in the liquid 5 is of the same importance. After possible explosion in the gas space 7 and spread of the floating elements 4 located in the gas space 7, they first, being emerged, overlap the liquid surface 6 and thereby phlegmatize combustion. And as the tests have shown the floating elements 4 scattered in the tank 1 completely recover the floating protective coating 3. The number of layers of the floating elements 4 in the liquid 5 should be at least one and a half.

[0032] Reduction of evaporation rate is well illustrated by the diagram of relationship between the level of excessive pressure and achievement time in the tank 1 in which pressure is released (fig. 8), where 13 - a curve for a tank without the floating elements, 14 - a curve for a rigid pontoon, 15 - a curve for a tank with the floating protective coating 3 from the numerous floating elements 4. The diagram on fig. 8 shows that with the presence of the floating protective coating 3 in which the floating elements 4 are placed in several layers, an excessive pressure is achieved for a longer time.

[0033] To prevent the surface corrosion of the floating elements 4, a layer of aluminum or its alloys should be applied to their surface. The preferred coating composition for the floating elements is Al_2O_3. Our studies have shown that the ceramic surface coating of the floating elements 4 makes effective corrosive protection of metallic surface for the overwhelming majority of petroleum products both of original manufacture and having various types of additives. The studies have shown high corrosive resistance of such coating in relation to a variety of flammable liquids and for benzenes it fully protects the surface of the floating aluminum elements 4 from corro-

sion.

[0034] So the assigned goal and the technical result are achieved.

Claims

1. A petroleum product storage tank, which consists of a body, a shell and a floating protective coating consisting of numerous floating elements as rotation bodies of the same shape, some part of which are located below a liquid surface in the tank and some of them - in the tank gas space **characterized in that** the floating elements in size and shape differ from each other for not more than 5%, the floating elements have a center of flotation offset from their geometric centre, and all floating elements are made of non-sparkling metal.

2. The tank according to claim 1 **characterized in that** the floating elements located in the gas space form not less than four layers.

3. The tank according to claim 1 **characterized in that** the floating elements located within the liquid form not less than one and a half layers.

4. The tank according to claim 1 **characterized in that** in its upper part, a grid with a cell less than the floating element diameter is installed.

5. The tank according to claim 1 **characterized in that** in its lower part above the liquid discharge-load level a grid with a cell smaller than the floating element diameter is installed.

6. The tank according to claim 1 **characterized in that** in its upper part an internal collaring is also made.

7. The floating element for the tank according to claim 1 made as a rotation body **characterized in that** it is made of aluminum or its alloy.

8. The floating element according to claim 3 **characterized in that** it is made with the ceramic coating of aluminum oxide or stainless steel.

9. The floating element according to claim 3 **characterized in that** the ratio of maximum diameter of the rotation body to its wall thickness is at least 60.

10. The floating element according to claim 3 **characterized in that** it is made with the minimum diameter not less than 10 mm.

11. The floating element according to claim 3 **characterized in that** it is made with the maximum diameter not more than 60 mm.

12. The floating element according to claim 3 **characterized in that** it has a spheroid, ellipsoid or egg-shaped form.

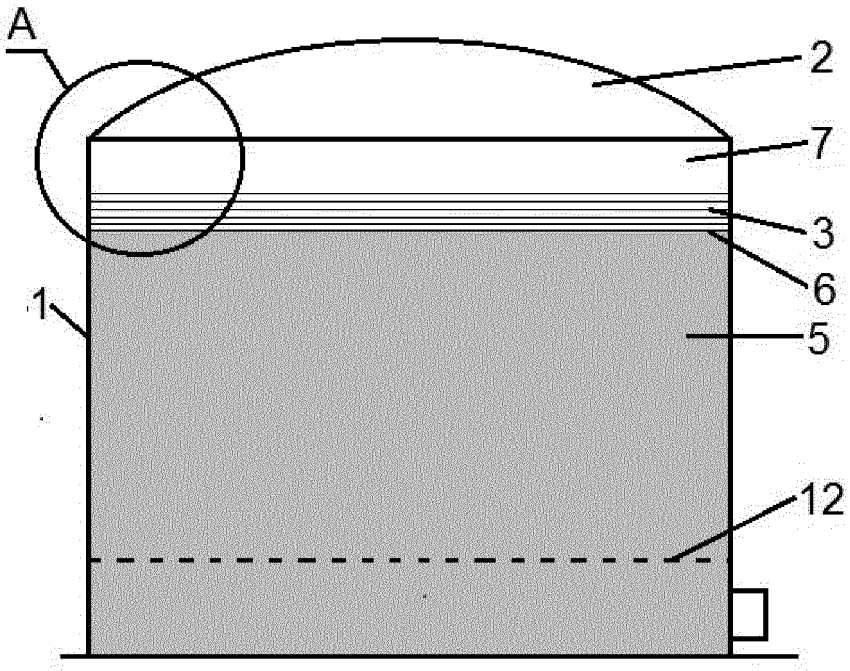

Fig. 1

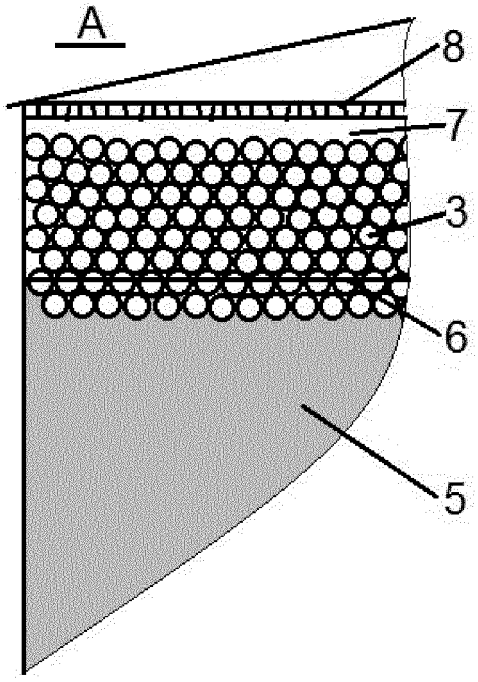

Fig. 2

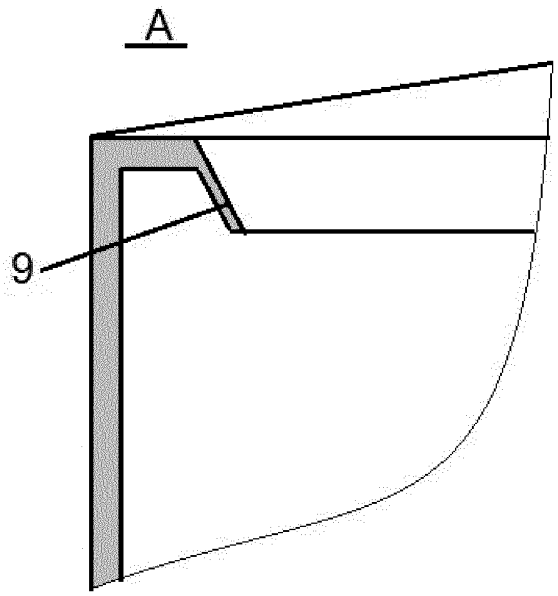

Fig. 3

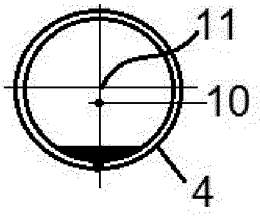

Fig. 4

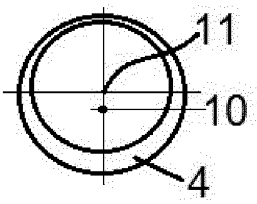

Fig. 5

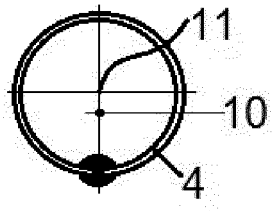

Fig. 6

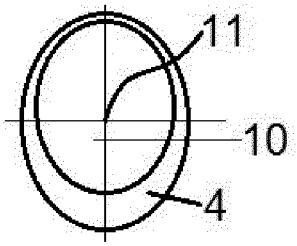

Fig. 7

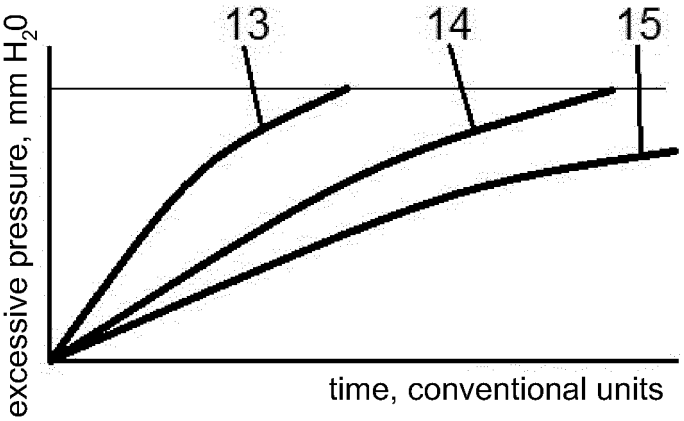

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 2015/051010

A. CLASSIFICATION OF SUBJECT MATTER
B65D 88/34 (2006.01)

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)
B65D 88/34, 90/06

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)
DWPI, Espacenet, RUPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU 1541142 A1 (BOGACHEV S.M. et al.) 07.02.1990, col. 2-3, fig. 1	1-12
A	RU 2127216 C1 (VALEEV RUSTEM IBRAGIMOVICH) 10.03.1999, p. 5	1-12
A	US 3938338 A1 (ARTHUR PROSPER CULLEN) 17.02.1976, col. 3, lines 59-62	1-12
A	WO 2012/049502 A2 (TRELLEBORG OFFSHORE U.K.LTD) 19.04.2012, p. 5, par. [0020]	1-12
A	US 20140144918 A1 (TRINITY HIGH - TECH PRODUCTS LTD.) 29.05.2014	1-12
A	PL 213116 B1 (INSTYTUT TECHNOLOGICZNO-PRZYRODNICZY) 31.01.2013	1-12

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Date of the actual completion of the international search	Date of mailing of the international search report
27 April 2015 (27.04.2015)	29 April 2015 (29.04.2015)
Name and mailing address of the ISA/ RU Facsimile No.	Authorized officer Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- GB 1191461 A **[0003]**
- RU 2127216 C1 **[0003]**
- RU 2163559 C1 **[0003]**
- EP 2530032 A1 **[0005] [0007]**
- US 12533218 B **[0006]**
- US 8616398 B2 **[0007]**

Non-patent literature cited in the description

- **SEMENOV N.N.** *Chain reactions,* 1986 **[0029]**