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(54) Title: METHOD FOR FABRICATING WATER REPELLENT THERMAL INSULATION NONWOVEN MATERIAL AND WATER REPELLENT THERMAL INSULATION NONWOVEN MATERIAL

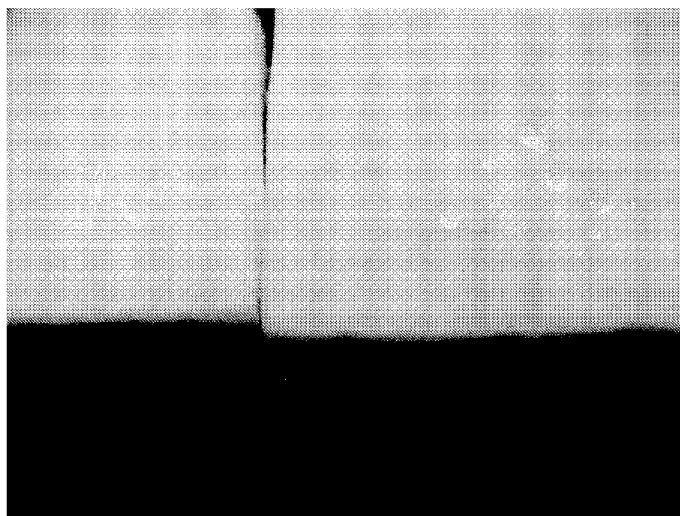


Figure 1

(57) Abstract: The present invention provides a method for fabricating water repellent thermal insulation nonwoven material and a water repellent thermal insulation nonwoven material fabricated by the method. The method for fabricating water repellent thermal insulation nonwoven material of the present invention comprises the steps of spraying a water repellent agent in a ratio of 0.5 to 20 g/m² onto one or both surfaces of a web formed from a principal fiber and optionally a low-melting-point fiber by a nonwoven process, and then heating the web at a temperature from 110 to 200 °C for 2 to 10 minutes. The method can fabricate water repellent thermal insulation nonwoven material in a quick, safe and low-cost way, and the resultant water repellent thermal insulation nonwoven material has good water repellent property and a superior warm effect under both dry and humid conditions.

**METHOD FOR FABRICATING WATER REPELLENT THERMAL INSULATION
NONWOVEN MATERIAL AND WATER REPELLENT THERMAL INSULATION
NONWOVEN MATERIAL**

TECHNICAL FIELD

6 The invention relates to the technical field of thermal insulation materials, and more specifically, to a method for fabricating water repellent thermal insulation material and a water repellent thermal insulation material fabricated by the method.

Background Art

12 Presently, the conventional thermal insulation materials available in the market mainly include natural battings (including cotton, wool, hemp, silk, kapok, bamboo fiber, and feather down, etc.) and synthetic battings (such as terylene, kapron, acrylic fibers, polypropylene fibers, polylactic acid fiber, cellulose fibers, and the like). Natural battings, such as cotton, wool and feather down, have a greatly reduced thermal insulation performance in a high humidity or drizzle-fog condition, due to their higher moisture regains, e.g. 8.5% for cotton and 16% for wool. On the other hand, although the normal synthetic fibers have lower moisture regains, e.g., about 0.4% for terylene, 0% for polypropylene fibers and 2% for
18 acrylic fibers, water vapor or water drops still can penetrate the battings because of the fluffy porous structure of the nonwoven materials, so that the thermal insulation effect is also lessened.

In order to impart a water repellent property to thermal insulation materials, many techniques have been applied currently, including a method for achieving expected protective and water repellent properties by laminating a layer of functional material on a nonwoven material, e.g. WO 2011019478 A1 and US
24 2010009112 A1; a method for imparting a water repellent property to fabrics by soaking the fabrics in a treating fluid, e.g. JP 8246347; and a method of treating fibers to impart a water repellent property to the fibers and then fabricating the fibers into nonwoven materials, e.g. US 5770308 and CN1136613A. However, the method of laminating other layers on a nonwoven material involves more processing steps, increases the weight of the thermal insulation material, and has negative impacts on the thickness of the material, so that the thermal insulation property will be affected. And for the method involving a step of
30 soaking the fabrics or treating fibers using a treating fluid, a large quantity of treating fluid is required, which not only increases the cost but also possibly causes safety and environmental concerns.

Content of Invention

The invention is intended to provide a method for fabricating water repellent thermal insulation nonwoven material in a quick, safe and low-cost way and a water repellent thermal insulation nonwoven material fabricated by the method.

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In order to achieve the above object, the invention, in one aspect, provides a method for fabricating water repellent thermal insulation nonwoven material which comprises the steps of spraying a water repellent agent in a ratio of 0.5 to 20 g/m² onto one or both surfaces of a web formed from a principal fiber and optionally a low-melting-point fiber by a nonwoven process, and then heating the web at a temperature from 110 to 200 °C for 2 to 10 minutes.

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The invention, in another aspect, provides a water repellent thermal insulation nonwoven material fabricated by the method according to the invention.

In the invention, the water repellent agent can be at least one selected from an organic fluorine-type water repellent agent, a silicone-type water repellent agent, a silicon-fluorine-type water repellent agent, and a hydrocarbon water repellent agent.

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In the invention, after the web is formed, a water repellent agent is sprayed onto one or both surfaces of the web. Then the water repellent agent, after heated, forms a film on the surface of each fiber in the surface layer of the thermal insulation nonwoven material, so that a water repellent web is formed. The resultant thermal insulation nonwoven material has a water repellent surface layer formed by even film-forming of the water repellent agent, and the water repellent surface layer has lowered surface energy, thereby achieving a water repellent property.

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Where the thermal insulation nonwoven material according to the invention comprises low-melting-point fibers, the low-melting-point fibers are melted while being heated, and bonded to their surrounding principal fibers to form a web with a certain strength. Moreover, since melting of the low-melting-point fibers and film-forming of the water repellent agent occur simultaneously while being heated, a higher

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affinity is generated between the fibers and the water repellent agent, so that the water repellent agent can form a water repellent film more evenly and more stably. As a result, the washing fastness of the water repellent thermal insulation nonwoven material is enhanced.

The water repellent thermal insulation nonwoven material according to the invention has an good water repellent property and a superior warm effect under both dry and humid conditions, but also can be fabricated in a quick, safe and low-cost way.

Description of Figures

Figure 1 is a picture showing the comparison between the water repellent effect of the water repellent thermal insulation nonwoven material according to the invention and that of a normal thermal insulation nonwoven material (left: a sample of the normal thermal insulation nonwoven material; and right: a sample of the water repellent thermal insulation nonwoven material according to the invention);

Figure 2 is a picture showing the spraying experiment conducted to the water repellent thermal insulation nonwoven material according to Example 1 of the invention, in which Figure 2A shows the spraying process and Figure 2B is a picture taken after spraying.

Figure 3 is a picture showing the spraying experiment conducted to a normal thermal insulation nonwoven material, in which Figure 3A shows the spraying process and Figure 3B is a picture taken after spraying.

SPECIFIC MODE FOR CARRYING OUT THE INVENTION

1. Method for fabricating water repellent thermal insulation nonwoven material

The method for fabricating water repellent thermal insulation nonwoven material of present invention comprises the steps of spraying a water repellent agent in a ratio of 0.5 to 20 g/m² onto one or both surfaces of a web formed from a principal fiber and optionally a low-melting-point fiber by a nonwoven process, and then heating the web at a temperature from 110 to 200 °C for 2 to 10 minutes.

In the invention, after the web is formed, a water repellent agent is sprayed onto one or both surfaces of the web. Then the web is heated, by which the low-melting-point fibers (if present) are melted and bonded to surrounding principal fibers to form a web with a certain strength; at the same time, the water repellent agent forms a film evenly, so that a water repellent web is generated.

- 6 The spraying amount of the water repellent agent is control within a range of 0.5-20 g/m², and preferably 2-10 g/m², so that the water repellent agent can be evenly distributed on the surface of the thermal insulation nonwoven material.

The heating temperature is selected on the basis of the film-forming temperature of a water repellent agent. Generally, the heating temperature is 110 to 200 °C, and preferably 120-150 °C.

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The water repellent agents useful for the invention are water repellent compounds, including an organic fluorine-type water repellent agent, a silicone-type water repellent agent, a silicon-fluorine-type water repellent agent, and a hydrocarbon water repellent agent, wherein the organic fluorine-type water repellent agent includes, for example, ScotchgardTM PM-3633, a protecting agent from 3M Corporation; OLEOPHOBOL[®] CP-SLA, a water repellent agent from Huntsman Corporation, etc.; the silicone-type
18 water repellent agent includes, for example, the silicone-type water repellent agent from Dow Corning, etc.; the silicon-fluorine-type water repellent agent includes, for example, UNIDYNETM TG-5521, a water repellent agent from Daikin; and the hydrocarbon water repellent agent includes, for example, Rudolph water repellent agent.

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The water repellent thermal insulation nonwoven material according to the invention may comprise
24 principal fibers and low-melting-point fibers, wherein the function of the low-melting-point fibers is to be bonded to their surrounding principal fibers by melting, so as to form a web with a certain strength.

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The low-melting-point fibers useful for the invention are the conventional low-melting-point fibers in the field, generally having a melting-point of 100-140 °C, a specification of 0.7D-7D and a length of 20-90mm, and include low-melting-point polyester fibers, low-melting-point polyethylene/ polypropylene
30 fibers, and low-melting-point polylactic acid fibers, etc. Moreover, the low-melting-point fibers may have

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a core-sheath structure, e.g. a modified PET/PET core-sheath structure, or a juxtaposition structure, e.g. a PP/PE juxtaposition structure.

The ratio of the low-melting-point fibers to the principal fibers is from 0:100 to 30:70, and preferably from 8:92 to 15:85.

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The principal fibers (i.e. conventional fibers) include solid fibers or hollow fibers. The solid fibers mainly function to fill the gaps in the web; whereas the hollow fibers mainly function as support to make the batting structure fluffier. Generally, the solid fiber has a specification of 0.5-15D and a length of 20-90mm, such as 2D*51mm terylene fiber or acrylic fiber, etc.; and the hollow fiber has a specification of 0.5-15D and a length of 20-90mm, such as 3D*64mm or 7D*64mm three-dimensional hollow and curly terylene, etc. Particularly, in the invention, the solid fiber may be selected from a synthetic fiber or a cellulose fiber, which has a circular or profiled cross-section; and the hollow fiber may be selected from a mono-pore or porous hollow fiber.

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The principal fiber useful for the invention may be a synthetic fiber, a natural fiber (chemical fiber) or a mixture of natural fiber and synthetic fiber. The natural fiber includes cotton, hemp, silk, kapok, bamboo, and wool fibers, or a mixture of two or more of these fibers. The synthetic fiber includes terylene, kapron, acrylic fibers, polypropylene fibers, nylon, polylactic acid fibers, cellulose fibers, or a mixture of two or more of these fibers. For a natural nonwoven material batting (cotton, etc.), an organic fluorine-type or silicone-type water repellent agent, e.g. OLEOPHOBOL[®] CP-SLA, a water repellent agent from Huntsman Corporation, and the like can be used. For a nonwoven chemical fiber material (terylene, acrylic fibers, polypropylene fibers, nylon, etc.), an organic fluorine-type or silicone-type water repellent agent, e.g. Scotchgard[™] PM-3633, a water repellent agent from 3M Corporation, or UNIDYNE[™] TG-5521, a water repellent agent from Daikin, can be used.

In the invention, the nonwoven process for fabricating the thermal insulation nonwoven chemical fiber material includes a nonwoven carding cross-lapping process, a nonwoven air-laid process, a spunbond process, a melt blown process, or a wet-laying process, etc.

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In addition, after the formation of the web, an adhesive spraying process can be carried out before or while the water repellent agent is sprayed. The purpose for conducting the adhesive spraying process is to smooth the surface of the web and to improve the strength of the web. The adhesive used in the adhesive spraying process includes an acrylic-based adhesive, an EVA (ethylene- vinyl acetate copolymer)-based adhesive, a polyurethane-based adhesive, a phenol-aldehyde-based adhesive, or an epoxy-based adhesive.

And the adhesive is used in an amount of 2 to 15 g/m².

2. Water repellent thermal insulation nonwoven material

The water repellent thermal insulation nonwoven material according to the invention can be fabricated by the method for fabricating water repellent thermal insulation nonwoven material according to the invention.

The water repellent thermal insulation nonwoven material according to the invention is characterized in that it has a water repellent surface layer on one or both surfaces thereof, wherein the water repellent surface layer is obtained by allowing the water repellent agent to form a film evenly on the surface of each fiber in the surface layer.

The water repellent surface layer can be present on one or both surfaces of the thermal insulation nonwoven material batting. And the water repellent agent is used in an amount of 0.5-20gsm, represented as the weight of a water repellent agent in a unit area of a nonwoven fabric. Insofar as above, a water repellent surface layer, in which the water repellent agent is evenly distributed, can be formed on the surface of the thermal insulation nonwoven material batting. The thermal insulation nonwoven material batting has a thickness of 0.1 to 10 cm, and preferably 1-5cm. And the water repellent surface layer, generally, has a thickness of 0.01-2cm, and preferably 0.3-1cm.

According to the invention, a water repellent thermal insulation nonwoven material can be manufactured in a quick, safe and low-cost way. The water repellent thermal insulation nonwoven material has a water repellent surface layer on one or both surfaces thereof. Figure 1 shows the water repellent performance of the water repellent thermal insulation nonwoven material according to the invention. In this Figure, the left panel shows a sample of a normal thermal insulation nonwoven material and the right panel shows a

sample of the water repellent thermal insulation nonwoven material according to the invention. On the sample of the water repellent thermal insulation nonwoven material according to the invention, water drops are formed, which indicate that the material has a significantly reduced surface energy, so that it cannot be wet by water and thus gains water repellent effect.

- 6 The invention is described in detail by referring to the specific Examples. All these Examples are used for exemplifying the invention only, and should not be understood as any restriction for the protection scope of the invention.

EXAMPLES

Example 1

- 12 2D/51mm low-melting-point polyester fiber (Huvis 2080 manufactured by Huvis) (2kg) and 2D/51mm solid terylene fiber (2D solid fiber manufactured by Yizheng Chemical Fiber) (8kg) were used. After a fluffing and carding cross-lapping process, a web was formed. Then a water repellent agent (3M ScotchgardTMPM-3633) was sprayed onto the upper surface of the web. Subsequently, the web was fed into a triplex oven. When the web was fed and dried on the second floor, the water repellent agent was again sprayed onto the bottom surface of the web. The spraying ratios on the upper and bottom surfaces
18 were 0.5gsm, 5gsm, 20gsm, respectively. The oven temperature was set to 120°C, and the drying period was 6-9 min. After that, the dried nonwoven material was coiled up and packed, so that Samples 1-3 of the water repellent thermal insulation nonwoven material according to the invention were obtained.

Example 2

- 24 4D/51mm low-melting-point polyethylene/ polypropylene fiber (ES fiber manufactured by Guangzhou ES Fiber. Co., Ltd.) (2kg) and cotton fiber (8kg) were used. After a fluffing process, a web was form by an air-laid process. Then the web was treated as in Example 1, except that an organic fluorine-type water repellent agent (such as OLEOPHOBOL[®] CP-SLA, a water repellent agent from Hunstman) was used; the oven temperature was set to 145°C; and the drying period was 5-8 min. The spraying ratio included 3 scenarios: 1) spraying on one surface, 2gsm; 2) spraying on both surfaces, 8gsm; and 3) spraying on both surfaces, 15gsm. As a result, the Samples 1'-3' of the water repellent thermal insulation nonwoven
30 material according to the invention were obtained.

Example 3

According to AATCC22-2005 standard, the water repellent effect was measured for the samples of the water repellent thermal insulation nonwoven material obtained in the Examples and the samples of the normal thermal insulation nonwoven material (carding cross-lapping-type thermal insulation terylene material). At a specified temperature and humidity, the samples were fixed on a sprinkler, then sprayed with 250ml of red colored water. After the spraying, the samples were removed from the sprinkler and shaken twice. The water adhesion status on the surfaces of the samples was observed. Figures 2 and 3 showed the results of the spraying experiments conducted to Sample 1 of the water repellent thermal insulation nonwoven material and the normal thermal insulation nonwoven material without treated by the water repellent agent, respectively.

The weights of the samples were measured before and after the spraying. Water content was calculated according to the following formula:

$$\text{water content \%} = (\text{weight after spraying} - \text{weight before spraying}) / \text{weight before spraying} \times 100\%$$

The warmth-keeping value Clo was measured for each sample. Clo value is defined as follow: where a person, either sitting still or engaged in mild mental work, feels comfortable in a condition of a room temperature of 25 °C, a relative humidity of less than 50% and a wind speed of less than 0.1 m/s, the cloth worn by this person has a warmth-keeping value of 1Clo.

The measurements were shown in Table 1.

Table 1

Sample #	Spraying amount of water repellent agent (gsm)	Weight before spraying (kg)	Weight after spraying (kg)	Water content (%)	Thickness (cm)	Clo
1	0.5	1.34	1.49	11.2	1.31	2.12

2	5	1.45	1.52	4.8	1.48	2.10
3	20	1.29	1.3	0.8	1.65	2.18
4	Blank*	1.29	7.94	515.5	0.96	1.68

Blank * represents this sample was not treated with the water repellent agent.

From Table 1, it was found that Samples #1-3, compared with the untreated samples, had good water repellent effect and improved warmth-keeping values.

What is claimed is:

1. A method for fabricating water repellent thermal insulation nonwoven material, comprising the steps of spraying a water repellent agent in a ratio of 0.5 to 20 g/m² onto one or both surfaces of a web formed from a principal fiber and optionally a low-melting-point fiber by a nonwoven process, and then heating the web at a temperature from 110 to 200 °C for 2 to 10 minutes.

2. The method according to claim 1, wherein the heating temperature is from 120 to 150 °C.

3. The method according to claim 1, wherein the water repellent agent is at least one selected from an organic fluorine-type water repellent agent, a silicone-type water repellent agent, a silicon-fluorine-type water repellent agent, and a hydrocarbon water repellent agent.

4. The method according to claim 1, wherein the ratio of the low-melting-point fiber to the principal fiber is from 0:100 to 30:70.

5. The method according to claim 4, wherein the ratio of the low-melting-point fiber to the principal fiber is from 8:92 to 15:85.

6. The method according to claim 1, wherein the low-melting-point fiber has a melting point ranging from 100 to 140 °C.

7. The method according to claim 1, wherein the low-melting-point fiber is 0.7 D-7D, and has a length of 20 to 90 mm.

8. The method according to claim 1, wherein the low-melting-point fiber has a core-sheath structure or a juxtaposition structure.

9. The method according to claim 1, wherein the low-melting-point fiber includes a low-melting-point polyester fiber, a low-melting-point polyethylene/ polypropylene fiber, and a low-melting-point polylactic acid fiber.

10. The method according to claim 1, wherein the principal fiber is a synthetic fiber, a natural fiber
6 or a mixture of natural fiber and synthetic fiber.

11. The method according to claim 10, wherein the natural fiber includes cotton, hemp, silk, kapok, bamboo, and wool fibers, or a mixture of two or more of these fibers.

12. The method according to claim 10, wherein the synthetic fiber includes terylen, kapron, acrylic
12 fibers, polypropylene fibers, nylon, polylactic acid fibers, cellulose fibers, or a mixture of two or more of these fibers.

13. The method according to claim 10, wherein the principal fiber is 0.5 to 15D, and has a length of 20 to 90mm.

14. The method according to claim 10, wherein the principal fiber is a solid fiber or a hollow fiber.
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15. The method according to claim 14, wherein the solid fiber is selected from a synthetic fiber or a cellulose fiber, which has a circular or profiled cross-section.

16. The method according to claim 14, wherein the hollow fiber is selected from a mono-pore or
24 porous hollow fiber.

17. The method according to claim 1, wherein the nonwoven process includes a nonwoven carding cross-lapping process and a nonwoven air-laid process.

18. The method according to claim 1, wherein the method further comprises an adhesive spraying
30 process carried out after the formation of the web and before or while the water repellent agent is sprayed.

19. The method according to claim 18, wherein the adhesive used in the adhesive spraying process includes an acrylic-based adhesive, an EVA-based adhesive, a polyurethane-based adhesive, a phenol-aldehyde-based adhesive, an epoxy-based adhesive, or a mixture of two or more of these adhesives.

6 20. The method according to claim 19, wherein the adhesive is used in an amount of 2 to 15 g/m².

21. A water repellent thermal insulation nonwoven material obtainable by the method according to any one of the preceding claims.

12 22. The water repellent thermal insulation nonwoven material according to claim 21, wherein the water repellent thermal insulation nonwoven material comprises a principal fiber and a low-melting-point fiber.

18 23. The water repellent thermal insulation nonwoven material according to claim 21, having a water repellent surface layer on one or both surfaces of the water repellent thermal insulation nonwoven material, wherein the water repellent surface layer is formed from the fiber and the water repellent agent forming a film on the fiber.

24 24. The water repellent thermal insulation nonwoven material according to claim 21, which has a thickness of 0.1 to 10 cm.

24 25. The water repellent thermal insulation nonwoven material according to claim 23, wherein the water repellent surface layer has a thickness of 0.01 to 2 cm.

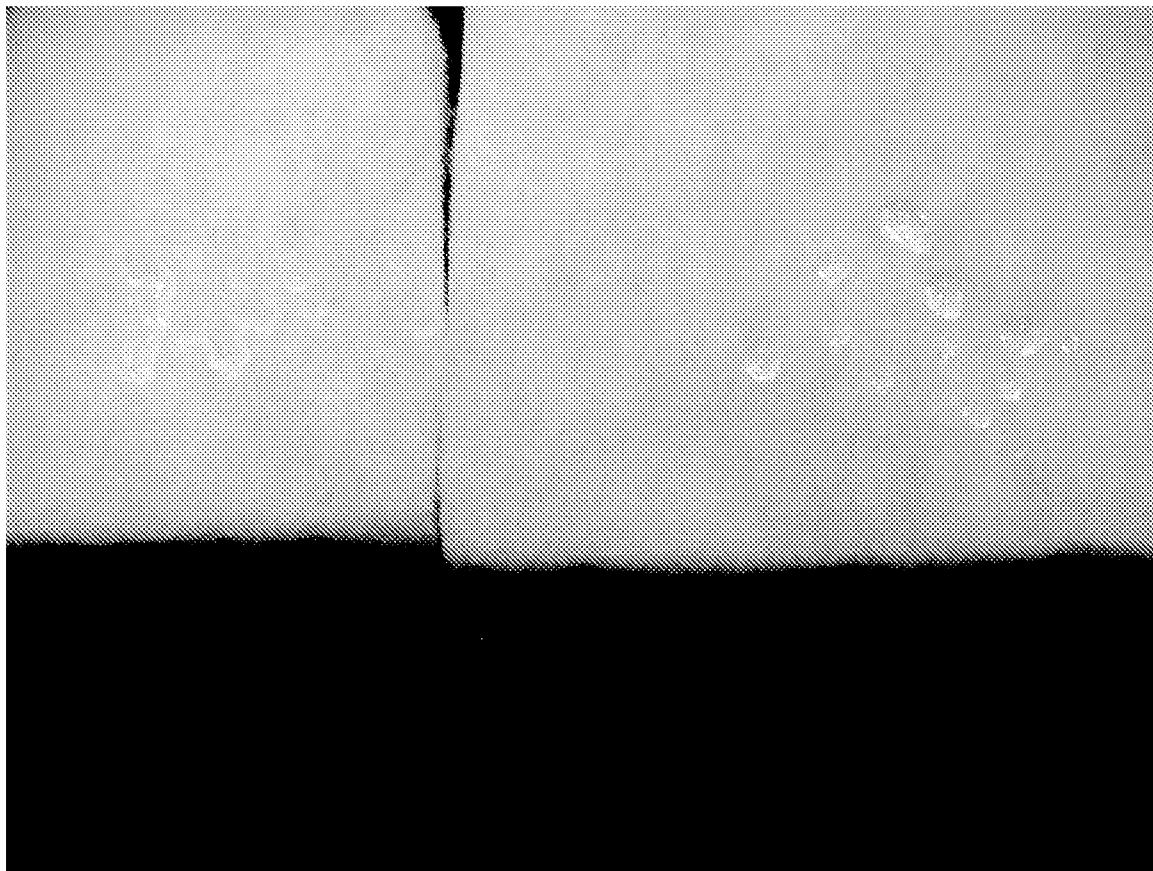


Figure 1

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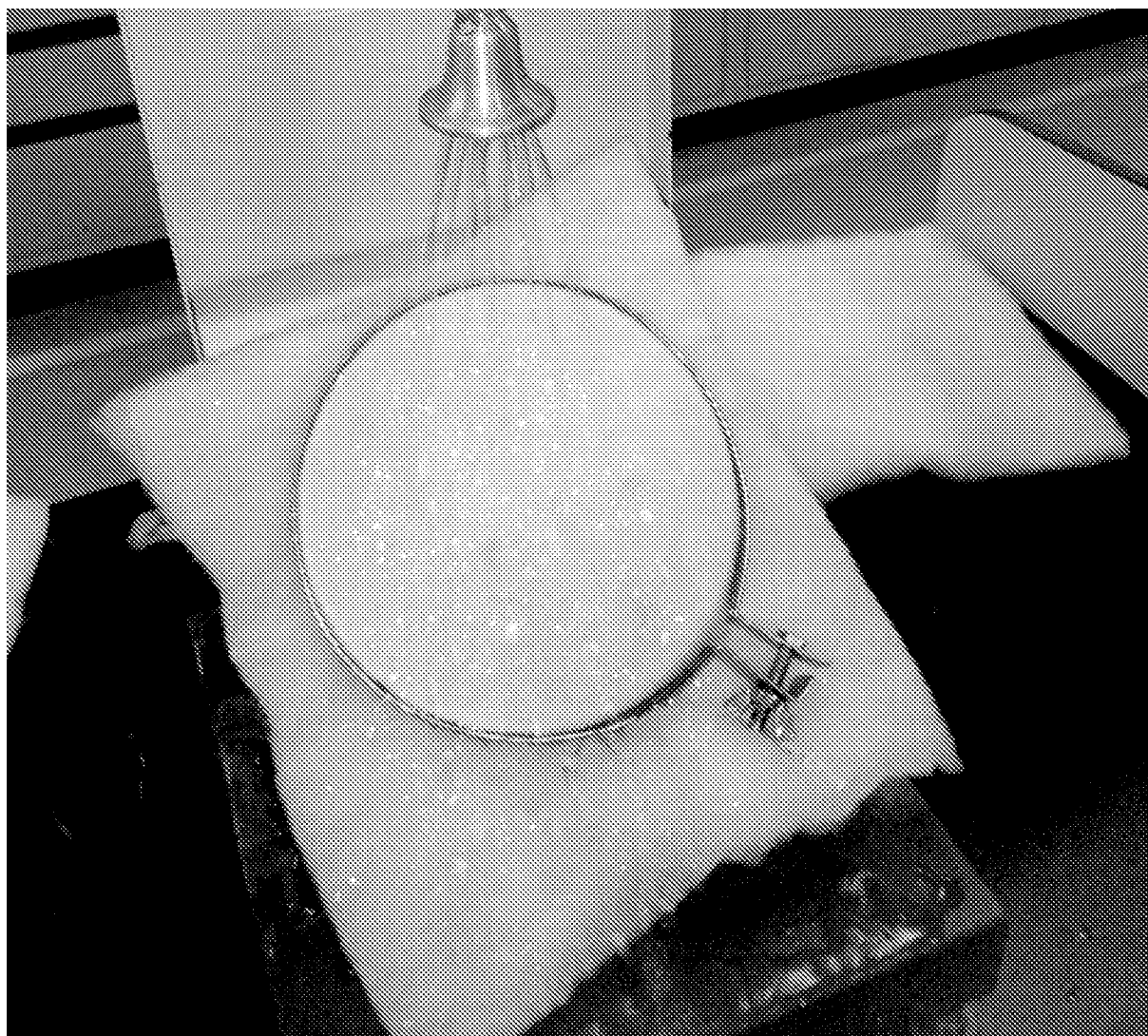


Figure 2A

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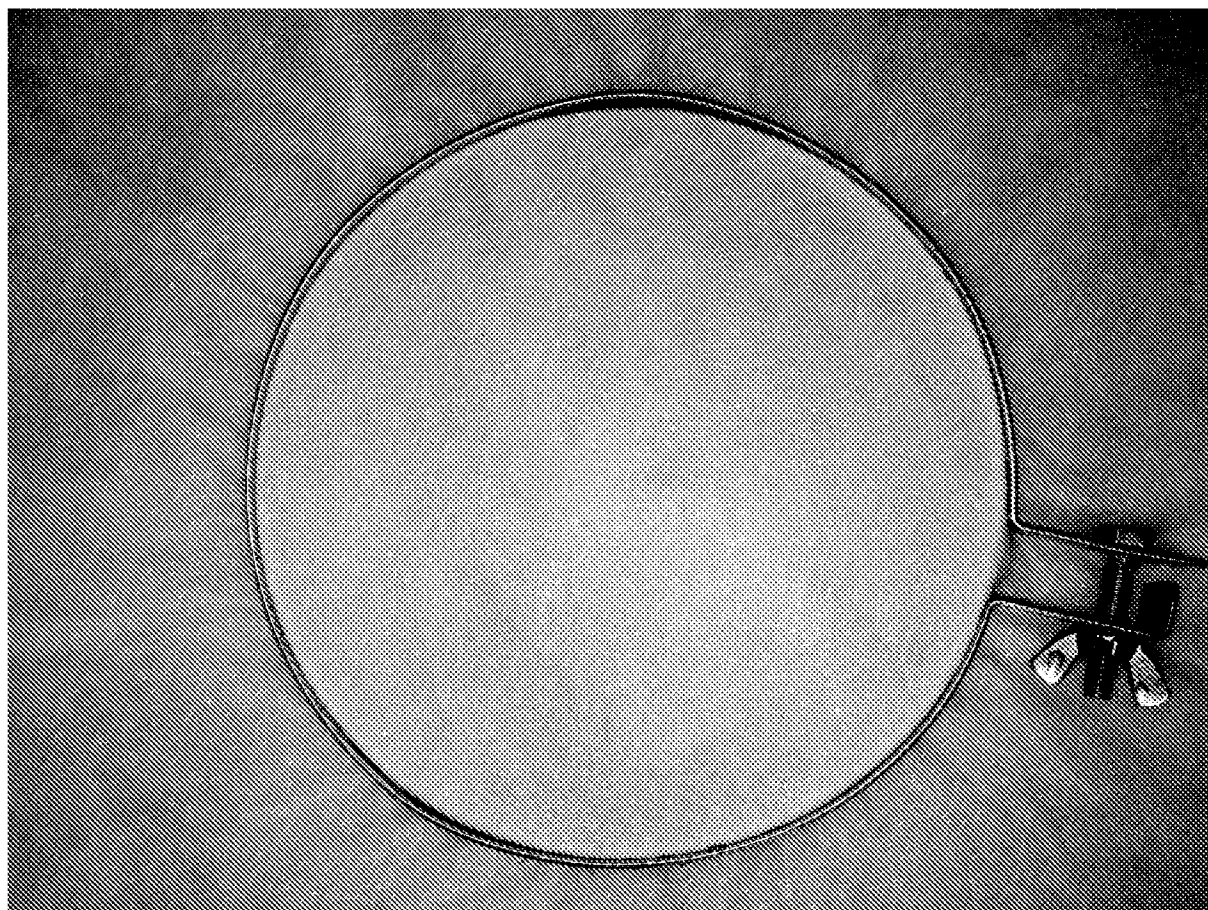


Figure 2B

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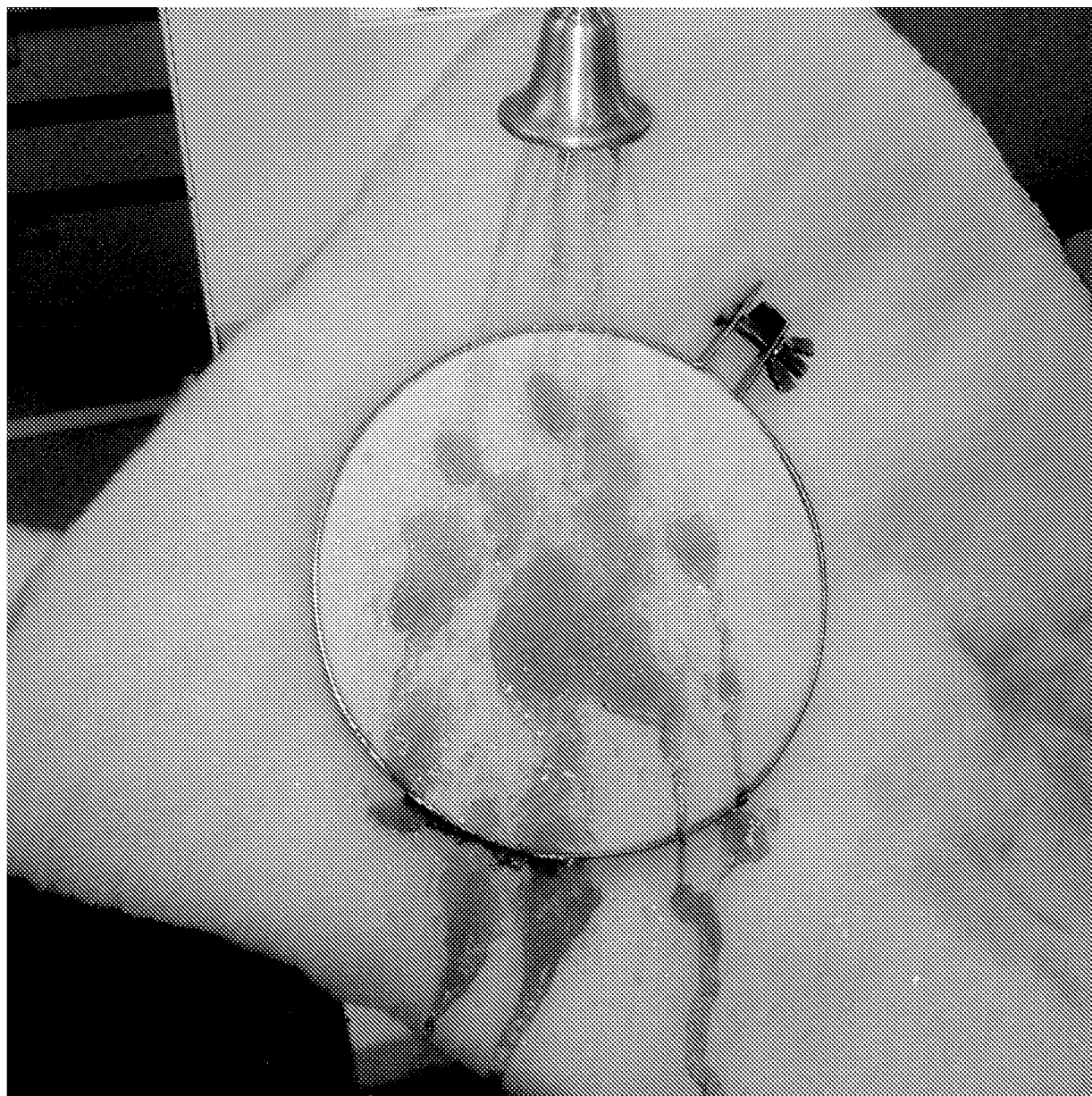


Figure 3A

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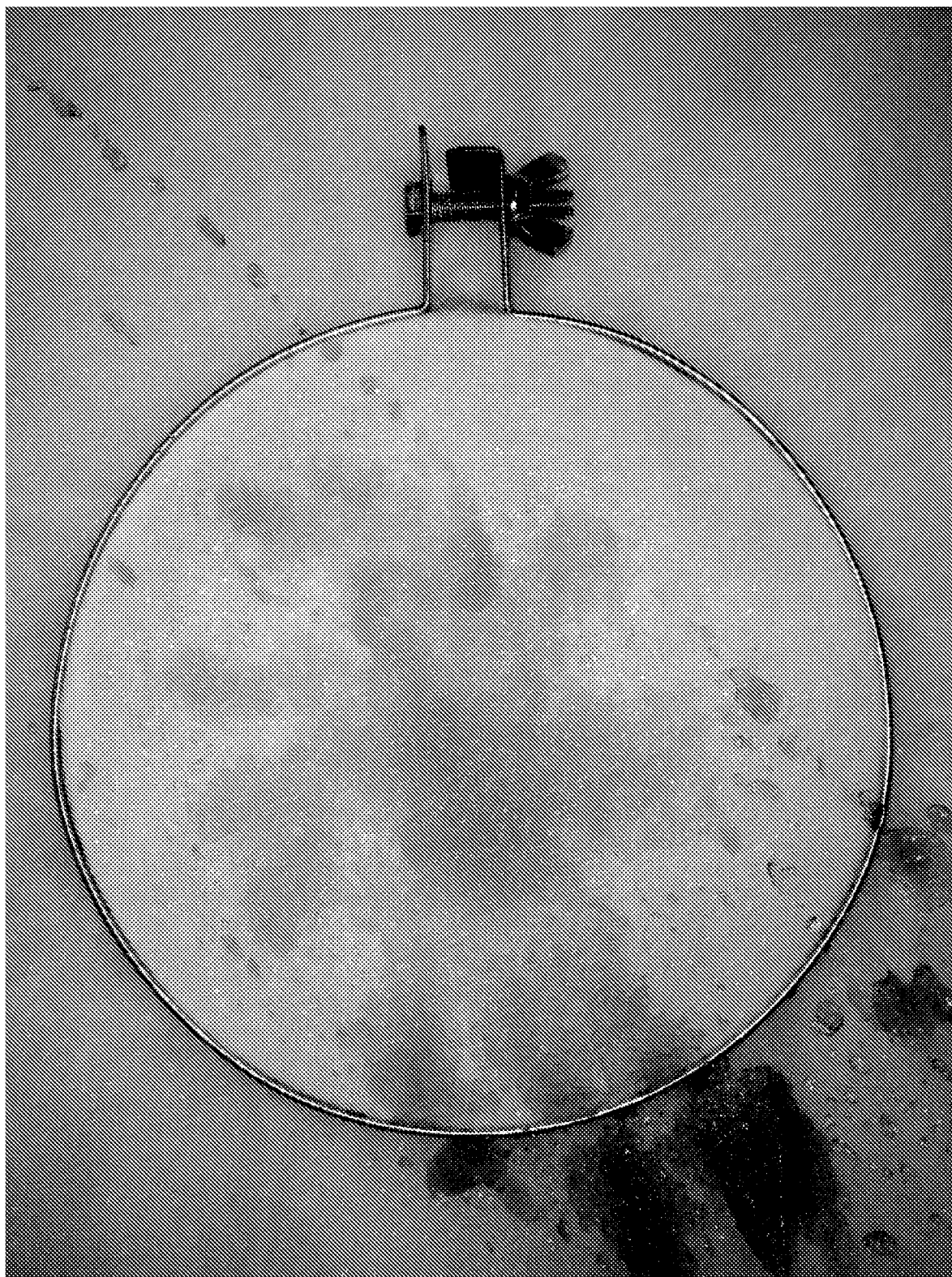


Figure 3B

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/076127

A. CLASSIFICATION OF SUBJECT MATTER

INV. D04H1/54 D06M23/06
ADD.

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)

D04H D06M

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 600 843 A1 (ALBANY INT CORP [US]) 8 June 1994 (1994-06-08) page 4, lines 27-29; claims 1,6; example 3 page 5, lines 34-36 -----	1-25
X	US 2009/252943 A1 (TAKEDA MASAOKI [JP] ET AL) 8 October 2009 (2009-10-08) paragraphs [0001], [0025]; claim 1 -----	1-25
A	WO 2009/084411 A1 (FUJI CORP [JP]; AOKI KATSUJI [JP]; NAKAMURA HIDEO [JP]; TAKEDA MASAOKI) 9 July 2009 (2009-07-09) abstract -----	1-25
A	JP 2000 296280 A (TOYOHASHI SEIMEN KK) 24 October 2000 (2000-10-24) abstract ----- -/-	1-25



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

25 February 2014

Date of mailing of the international search report

05/03/2014

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/076127

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 279 677 A2 (ALBANY RESEARCH UK [GB]) 24 August 1988 (1988-08-24) claims 1-3,9 -----	1-25
A	EP 0 331 819 A2 (DOW CHEMICAL CO [US]) 13 September 1989 (1989-09-13) column 1, lines 1-7; claim 1 -----	1-25
A	GB 1 126 388 A (GLANZSTOFF AG) 5 September 1968 (1968-09-05) the whole document -----	1-25

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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