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(54) **WATER-SOLUBLE FLEXIBLE FASTENING STRIP**

(57) Environmentally-friendly flexible fastening strip for tying food product bags or packaging, said strip comprising a base body of flexible and mouldable material,

wherein the flexible material is comprised of a water-soluble polymer material formed from polyvinyl alcohol resin.

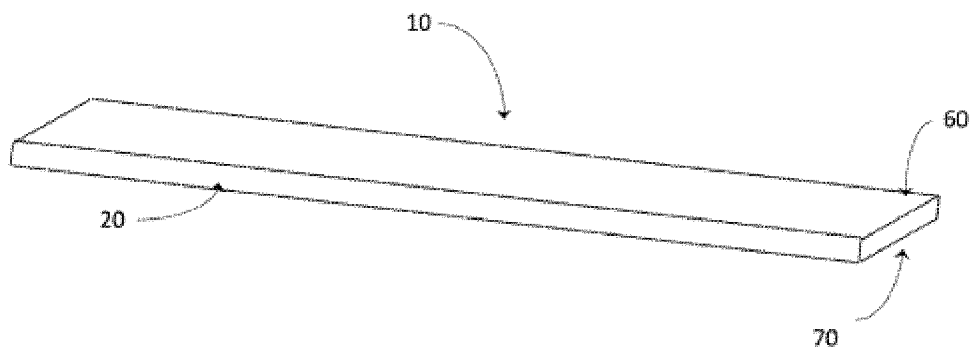


FIG. 1

Description**TECHNICAL FIELD OF THE INVENTION**

5 **[0001]** The present invention is directed to the field of fastening elements for closing bags or packaging, in general, it refers to an aid accessory for closing or tying bags. In particular, the present invention refers to a environmentally-friendly, flexible fastening strip for tying food product bags or packaging, said strip being dissolvable a few minutes after contact with water and being eliminated from the surface in an environmentally-friendly manner, reducing the tons of plastic generated by plastic waste that is disposed of in the trash. The flexible fastening strip can perform the function of closing one access
 10 side of a flexible packaging, which at the time of use squeeze the neck of the packaging bag and its ends are twisted together to achieve the fastening or sealing of the packaged items.

BACKGROUND OF THE INVENTION

15 **[0002]** Flexible fastening strips are used for different fastening and closing purposes. Typically, flexible fastening strips are used for sealing a package that has an open end, such as a bag. For sealing the package, the packaging material adjacent to the open end is put together. The flexible fastening strips are spread around the rolled up packaging material until the end portions of the flexible fastening strip are adjacent to each other. The end portions are then twisted relative to the remainder of the flexible fastener strip to secure the flexible fastener strip to the package.

20 **[0003]** Flexible fastening strips may include a flexible metal filament that is enclosed into a plastic material. Flexible fastening strips have many advantageous properties that have led to their widespread use, for example, flexible fastening strips are easily applied by manual or high-speed mechanical operations. Furthermore, their fastening capacity is not significantly affected by the multiple fastening and unfastening cycles to which the flexible fastening elements are subjected.

25 **[0004]** Flexible fastening strips play an important role in many food packaging applications since such fastening strips allow consumers quickly accessing and resealing a product container repeatedly. A disadvantage of the currently existing flexible fastening strips is that after their use they are discarded by consumers, becoming part of the tons of plastic waste generated in the world. To overcome this difficulty, the present invention develops an environmentally-friendly, flexible fastening strip for fastening bags or packaging containing all types of products, particularly food products.

30 **[0005]** Numerous attempts have been made over time to provide for a polymeric twisted tie displaying desirable characteristics of tenacity and flexibility while also being able to be easily fastened and unfastened over numerous cycles. In this regard, reference is made to Kirkpatrick, who in patent US 3,565,738 discloses a polymeric binder material in the form of semi-rigid plastic strips with a high tensile modulus and good folding properties similar to those of a wire.

35 **[0006]** On the other hand, document DE 7615537 U discloses a clipband type of closure, which comprises a strip of plastic material having reinforcing wires embedded along the longitudinal edges and which is provided with a longitudinal rib on the side of the closure, approximately in the center of the central body, between the reinforced longitudinal edges. This longitudinal rib is claimed to increase the grip of the closure and the stability of the closure.

[0007] In other examples of the state of the art, there is Thomas, invention patent US 3,535,746; Moon, invention patent US 3,604,066; and Hoard, invention patent US 3,945,086, wherein polymeric closure devices are described. However,
 40 none of these polymeric closure devices are environmentally-friendly and, furthermore, they are not suitable for applying ties in high-speed mechanical packaging machinery.

[0008] Currently, flexible fastening closures are the most commonly used to fasten food bags, cables in electronic item packaging, among other uses. Flexible fastening strips can come in different colors, sizes, prints, designs and materials. The resistance of flexible fastening strips also changes depending on their use. Although flexible fastening strips are very
 45 important for packaging, they currently have a negative impact on the environment.

[0009] Flexible fastening strips are widely used today, many packaged food products, such as vegetables and bread, are secured and tied with flexible fastening strips. Flexible fastening strips are also used to fastening household items, such as for securing plants or cables inside or outside the home. It would be very difficult to manage without them in the near future. However, the abundance of flexible fastening strips under production and in use generates a disposal problem. A good way
 50 to reduce the environmental impact of a product is recycling said product, as a result it enters the production circuit and becomes part of the circular economy. However, recovery or collection of flexible fastening strips is not feasible given the small size thereof.

[0010] Current fastening strips are made entirely of a flexible polymeric material having sufficient mechanical strength to resist small tensile forces. There are also fastening strips made up of a coating material, which is generally a plastic (polyethylene) or paper (smooth or metallic) material, being this material capable of coating metal wires that can be made
 55 of galvanized or stainless steel having between 0.410 and 0.0132 of diameter.

[0011] The material forming the fastening strips can be designed in different colors with or without printing. If you look at all the individual components forming the flexible fastening strips, you can see the difficulty of their recycling. Each

component is so small that it cannot be recycled into a new product. Therefore, all used flexible fastening strips sadly end up in landfills.

[0012] Many of the products that are considered environmentally-friendly are biodegradable; bacteria and other microorganisms can break them down into smaller parts, without the products causing any harm to the environment. It is known that flexible fastening strips are not recyclable, but are they biodegradable? So far, only flexible paper fastening strips could be considered as biodegradable. Although the metal wires or filaments in flexible fastening strips are not biodegradable. (Source: <https://www.conserve-energy-future.com/are-twist-ties-recyclable.php>)

[0013] Currently, no studies related to the quantity of flexible fastening strips being produced or the environmental impact of flexible fastening strips not being recyclable and, in the best scenario, being reusable to avoid the impact of discarding them as garbage are known. However, CiperChile (Journalistic Research Center), in an article published in March 2021 (Source: <https://www.ciperchile.cl/2021/03/26/plastico-por-que-no-podemos-deszandonos-of-the-but-we-have-to-do-it/>), refers to a report published by the UN, focusing mainly on plastic. According to this study, consumers must learn to reduce the usage of single-use plastics and demand the reduction of plastic usage in containers and packaging, being the priority to replace plastic materials with more environmentally-friendly raw materials. In other words, those which degrade faster, have alternative applications in other uses and eliminate the need to use toxic chemicals in their design and manufacturing.

[0014] "The current plastic pollution, which worries a group of Chilean scientists (Urbina et al, 2020), *due to the growing evidence also in our country of the presence of plastics, micro- and nano-plastics in the environment and living beings, should make us think about a paradigm shift in our production and consumption system that should think and act in a less linear and more circular way* The presence of plastics in the tissues of plants, animals and people is a direct threat to our health, because as said above, plastics do not come alone, but are also vectors of other highly toxic pollutants for nature and humans, and having a long lifecycle (environmentally persistent), not only are a threat for our generation but also for future generations."

[0015] Consequently, flexible fastening strips are known in the current state of the art, but after they are used and accumulate transforms themselves into highly harmful waste for the environment, therefore, there is a need for flexible fastening strips manufactured from environmentally-friendly materials. It is acknowledge that environmentally-friendly materials are known and used in the state of the art for manufacturing different plastic items, but their applications have been more focused on compostable or naturally degrading elements, or those manufactured from recycled elements. However, the state of the art has not been focused on forming a water-soluble (hydrosoluble) flexible fastening strip that can be easily degraded in a short period of time, unlike current flexible fastening strips that degrade over long periods of time (years) when they are discarded.

[0016] Therefore, there is a need for environmentally-friendly, flexible fastening strips for tying food product bags or packaging, which degrade quickly and do not have to end up in landfills or the sea.

SUMMARY OF THE INVENTION

[0017] An object of the present invention is to provide a flexible fastening strip for tying food product bags or packaging, where said strip is completely water-soluble, made of environmentally-friendly materials to reduce the contamination produced by the increasing usage of common plastic materials in items in everyday life.

[0018] Previously, the inventors had designed water-soluble plastic and non-woven fabric bags, forming the company Solubag. In their studies, they arrived at a chemical formula based on polyvinyl alcohol (PVA) (a water-soluble material) to which they added other naturally occurring materials, thus generating bags and materials that dissolve in contact with water, avoiding ocean contamination. (Source: <https://www.explorab.cl/noticias/innovacion-chilena-de-bolsas-hidro-solubles-conquista-mercados-mundiales/>).

[0019] Based on the above, the inventors directed their efforts and research to develop a flexible fastening strip that dissolve quickly and, in this way, solve the problem of contamination due to disused strips and their disposal in the trash when they are no longer useful, which has not been anticipated by the prior art up to date.

[0020] Consequently, the present invention solves this problem based on an environmentally-friendly, flexible fastening strip for tying up food product bags or packaging, which comprises a base body of flexible and mouldable (or malleable) material formed from a water-soluble polymeric material such as polyvinyl alcohol resin and which may include at least one filament inserted along the strip, the filament mainly being a flexible polymeric material, although a flexible metallic material is not ruled out.

BRIEF DESCRIPTION OF THE FIGURES

[0021] A detailed description of the invention will be carried out together with the figures that form part of this application.

[0022] It is important to indicate that the figures only act as support elements for a better understanding of the invention, the components thereof not being represented on a real or proportional scale. The invention cannot be limited only to what

appears in the figures, since they only are a manner of teaching the important elements of the flexible fastening strip, elements that are generally known in the state of the art may not be included. So then, we have the following figures:

Figure 1: Schematic representation of a flexible fastening strip. An isometric view of a flexible fastening strip according to a first embodiment of the present invention is shown.

Figure 2: Schematic representation of a flexible fastening strip. A front view of the flexible fastening strip according to the first embodiment of the present invention is shown.

Figure 3: Schematic representation of a flexible fastening strip. An isometric view of a flexible fastening strip according to a second embodiment of the present invention, which includes an inserted filament, is shown.

Figure 4: Schematic representation of a flexible fastening strip. A front view of the flexible fastening strip according to the second embodiment of the present invention is shown.

Figure 5: Schematic representation of a flexible fastening strip. An isometric view of a flexible fastening strip according to a third embodiment of the present invention, which includes two inserted filaments, is shown.

Figure 6: Schematic representation of a flexible fastening strip. A front view of the flexible fastening strip according to the third embodiment of the present invention is shown.

Figure 7: Schematic representation of a flexible fastening strip. An isometric view of a flexible fastening strip according to a fourth embodiment of the present invention, which is in the form of a continuous thread, is shown.

Figure 8: Schematic representation of a flexible fastening strip. A front view of the flexible fastening strip according to the fourth embodiment of the present invention is shown.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The following definitions are provided for a better understanding of the present invention, these definitions should only be understood as elements that help to understand the particular technical characteristics in this technical field.

[0024] As used in the present invention, the term "*flexible fastening strip*" refers to a flat or cylindrical element formed from a flexible material of small dimensions, which is used for fastening, securing or tying the openings of bags, plants, cables, etc. It is used by wrapping the wire around the object to be fastened or tied, and then twisting the ends.

[0025] As used in the present invention, the term "*water-soluble material*" or "*hydrosoluble*" refers to those materials that can be diluted in water to form a new substance (disintegrating completely from its original form). In this invention, the flexible fastening strip is made from "*water-soluble material*" which dissolves upon contact with water, so it can also be identified as "*hydrosoluble*".

[0026] As used in the present invention, the term "*polyvinyl alcohol*" or "*PVA*" is a water-soluble, colorless (white), odorless synthetic polymer. Having the formula $(C_2H_4O)_x$; density of 1.19 g/cm³; melting point 200 °C; and boiling point of 228 °C.

[0027] As used in the present invention, the term "*density*" refers to a quantity referring to the amount of mass in a given volume of a solid substance or object. In the case of polymers, these can have low or high density and their use depend on this, whether for producing rigid or malleable materials, for extrusion or fusion processes, to support high or low temperatures, among others.

[0028] The advantages of the environmentally-friendly, flexible fastening strip of the present invention are obtained from the material used in its manufacturing, that is, from a water-soluble material, which becomes especially relevant for consumers that have developed a growing environmental awareness in recent years. It is clear that previous art has only focused on producing flexible fastening strips, which are neither biodegradable nor water-soluble.

[0029] Another great advantage of the present invention is that the worked made on the properties of the material makes it soluble only in water, therefore, the flexible fastening strip resists adequately the moisture and heat from the user manipulation.

[0030] Another advantage of using PVA as a material for the formulation of the flexible fastening strip is that it has a rapid dissolution and elimination, so when it has completed its useful life or the user does not want to continue using the same, the flexible fastening strip can be quickly dissolved, unlike other materials of the prior art from which flexible fastening strips are manufactured that are neither biodegradable nor water-soluble, whereby a complete degradation can take years.

[0031] Finally, the density used in the PVA polymer for the flexible fastening strip, allows it to be resistant, safe and soluble in water, to make it environmentally-friendly.

[0032] Thus, the present invention has developed a technical advance in the manufacturing of a flexible fastening strip completely water-soluble, having good quality, low cost, resistance, and being environmentally sustainable, which breaks down in cold water. For a better understanding of the present invention, Figures 1 to 8 show representations of the water-soluble flexible fastening strip allowing a better understanding of the object of the invention.

[0033] Thus, the present invention discloses an environmentally-friendly, flexible fastening strip for tying food product bags or packaging, which is comprised of a base body made of flexible and mouldable (or malleable) material, wherein the flexible material is comprised of a water-soluble polymeric material. Wherein, said water-soluble polymeric material is formed from polyvinyl alcohol resin, which may be mostly or completely polyvinyl alcohol.

[0034] Figure 1 shows the first embodiment of the present invention, which corresponds to an isometric view of a flexible fastening strip 10 with a rectangular cross section. The flexible fastening strip 10 comprises an elongated base body 20 having a first face 60 and a second face 70 (upper face and lower face, respectively). Figure 2 shows a front view of the flexible fastening strip 10.

[0035] Figure 3 shows, in a second embodiment of the invention, an isometric view of a flexible fastening strip 110 comprising a base body 120 having a rectangular cross section and a filament 130 inserted along the longitudinal central section of the strip. Figure 4 shows a front view of the flexible fastening strip 110.

[0036] Figure 5 shows, in a third embodiment of the invention, an isometric view of a flexible fastening strip 210 comprising a base body 220 having a rectangular cross section and two filaments 230a, 230b each one inserted longitudinally into the proximity of each longitudinal edge 240, 250 of the strip. Figure 6 shows a front view of the flexible fastening strip 210.

[0037] Figure 7 shows, in a fourth embodiment of the invention, an isometric view of a flexible fastening strip 300, which comprises a single elongated base body having circular cross section. Figure 8 shows a front view of the flexible fastening strip 300. In this case, the base body is in the form of a continuous thread whose diameter ranges between 0.5 and 5 millimeters.

[0038] The environmentally-friendly, flexible fastening strip described in the present invention has a rectangular base body. Thus, in some of its embodiments, the flexible fastening strip will have a base body that will have a rectangular shape and a rectangular cross section throughout its entire length. Said flexible fastening strip may be arranged in independent segments or continuously, and may range between 10 and 15,000 millimeters, preferably between 10 and 5,000 millimeters. Likewise, the environmentally-friendly flexible fastening strip can be supplied in separate units having the same length or continuously rolled on a spool.

[0039] As already mentioned, the environmentally-friendly flexible fastening strip having a base body rectangular in shape, can include at least one filament inserted throughout the strip, said filament being made of a flexible polymeric material or a flexible metallic material. The filament of flexible polymeric material may be formed from polyvinyl alcohol resin or other water-soluble polymer. When said filament is made of a flexible metallic material, said filament will obviously not be water-soluble, but, since the rest of the material of the strip will be water-soluble, after the disintegration of the polymeric material, the metallic filament will remain free in the water, and can be recovered or removed from the water without difficulty for subsequent recycling.

[0040] It should be understood that when the invention refers to a rectangular cross section, said description encompasses micrometric or millimetric thicknesses, so in some cases the flexible fastening strip can be a thin sheet (which will have a rectangular cross section under a magnified view) or have a clearly identifiable greater thickness. Likewise, when the invention refers to a circular cross section, said description encompasses any cross section having curvature, such as, for example, semicircular, oval, sinusoidal, etc.

[0041] The flexible fastening strip according to the invention can be applied to a gathered neck of a flexible container (for example a bag) by folding the flexible fastening strip around the neck and twisting its ends around each other.

EXAMPLES

[0042] The description of the required tests to demonstrate the effectiveness of a flexible fastening strip for tying food product bags or packaging, being said flexible fastening strip water-soluble and environmentally-friendly, is demonstrated through the following comparative examples.

Example 1: Formulation of flexible fastening strip for tying food product bags or packaging made from polyvinyl alcohol resin.

[0043] The manufacture of the water-soluble flexible fastening strip, for tying food product bags or packaging is made based on techniques known in the art by melt extrusion or spunbonding, as disclosed in patent applications US 2019/0152665 A1 and US 2020/0024438 A1 (which are incorporated herein by reference), using a PVA resin dissolvable in water.

[0044] PVA is traditionally made by polymerizing vinyl acetate and then hydrolyzing the polymer to an alcohol. Polyvinyl

alcohols differ in their polymerization and hydrolysis degree. The temperature at which PVA dissolves can differ by altering the orientation of the polymer, changing its degree of hydrolysis and crystallization, which are techniques widely known and disclosed in the state of the art.

[0045] The present invention can generate a flexible PVA fastening strip that dissolves in water in order to ensure that it dissolves with tap water, such as drinking water or water from another source.

[0046] For the flexible fastening strip having adequate strength, it is formulated with a PVA having sufficient density for the fastening strip could resist traction and torsion under use.

[0047] When the flexible fastening strip includes PVA filaments, these will have a slightly higher density than the density of the rest of the fastening strip. In this case, as mentioned above, the fastening strip formed with PVA resin will have a lower density, being more elastic and flexible than the PVA filaments. On the other hand, when the flexible fastening strip does not include any type of filaments, its density will be the same throughout its structure. As mentioned above, the density with which the PVA is worked to form the fastening strip plays a relevant role, since it must be worked in a density range between 1.1 and 1.55 g/cc, so both a strong and flexible fastening strip is formed at the same time.

Example 2: Disintegration test of the health kit.

[0048] Scope: This test is a simple method, which consists of putting the flexible fastening strip without filaments in a 2 liter beaker and measure the time it takes to dissolve. Two additional conditions are tested: 1) with shaking, and 2) without shaking. This in order to determine how long it takes for the product to dissolve in stagnant water, as well as in moving water, depending on where the product may end up when involuntarily discarded into the environment.

[0049] Materials: i) Magnetic stirrer (CORNINGO brand), at medium speed (700-800 rpm); ii) magnetic bar; iii) stopwatch; and iv) 2 L beakers.

[0050] Results: The dissolution time of the flexible fastening strip in water was measured with and without agitation, results are shown in Table 1. The results showed that the flexible fastening strip under agitation dissolves much faster than without agitation (stagnant water). A 50% disintegration was reached when a disintegration of the material was sufficient to release the internal content, leaving pieces of different sizes and shapes in the beaker filled with water. While, a 100% disintegration was reached when the material was completely dissolved and integrated into the water and no particles of any size were seen inside the beaker.

Table 1: Results from a Test of Disintegration in Water of a Fastening Strip Having 30 mm Long and a PVA Density of 1.1 g/cc.

Degradation Level	DEGRADATION TIME	
	Flexible fastening strip Without agitation	With agitation
50%	140 seconds	16 seconds
100%	293 seconds	42 seconds

[0051] Therefore, the tests support and certify that the flexible fastening strip is completely soluble in water in a short time, which differs from other flexible fastening strips of the prior art that are not water-soluble, so it can take years for their disintegration.

[0052] Consequently, the previous examples and description of the invention support the invention in any of its forms, demonstrating that it has a technical advantage over the prior art. Furthermore, the material used is known in the prior art, meets FDA standards and requirements, and is environmentally-friendly, and finally, a water-soluble flexible fastening strip made entirely of PVA has not been anticipated.

[0053] The scope of the flexible fastening strip described in the present invention, should not be limited only to the components disclosed in the text itself (shapes, arrangements, designs), since there may be other types of designs not indicated in the figure section.

Claims

1. Environmentally-friendly, flexible fastening strip for tying food product bags or packaging, **CHARACTERIZED in that** it comprises a base body of flexible and mouldable material wherein the flexible material is comprised of a water-soluble polymeric material.
2. The environmentally-friendly, flexible fastening strip according to claim 1, **CHARACTERIZED in that** the water-

soluble polymeric material is formed from polyvinyl alcohol resin.

3. The environmentally-friendly, flexible fastening strip according to claim 1, **CHARACTERIZED in that** the base body is in the form of a continuous thread.
4. The environmentally-friendly, flexible fastening strip according to claim 3, **CHARACTERIZED in that** the continuous thread form has a diameter between 0.5 and 5 millimeters.
5. The environmentally-friendly, flexible fastening strip according to claim 1, **CHARACTERIZED in that** the base body has a rectangular shape.
6. The environmentally-friendly, flexible fastening strip according to claim 5, **CHARACTERIZED in that** the rectangular-shaped strip has a length between 10 and 5,000 millimeters.
7. The environmentally-friendly, flexible fastening strip according to claim 6, **CHARACTERIZED in that** the strip can be rolled on a spool.
8. The environmentally-friendly, flexible fastening strip according to claim 6, **CHARACTERIZED in that** the strip can be found in separate units but having the same length.
9. The environmentally-friendly, flexible fastening strip according to claim 5, **CHARACTERIZED in that** the rectangular-shaped base body includes at least one filament inserted along the strip.
10. The environmentally-friendly, flexible fastening strip according to claim 9, **CHARACTERIZED in that** the filament is made of a flexible polymeric material or a flexible metallic material.
11. The environmentally-friendly, flexible fastening strip according to claim 9, **CHARACTERIZED in that** the filament is inserted into the central longitudinal section of the strip.
12. The environmentally-friendly, flexible fastening strip, according to claim 9, **CHARACTERIZED in that** two filaments are inserted, each one in the proximity of each longitudinal edge of the strip.

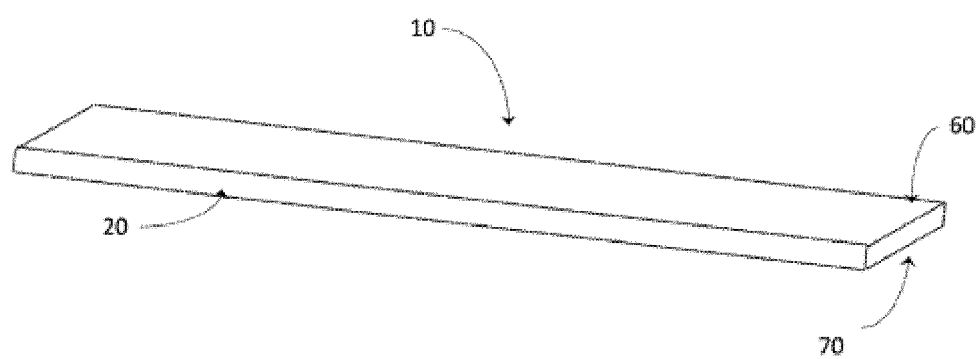


FIG. 1

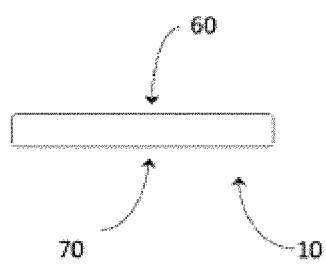


FIG. 2

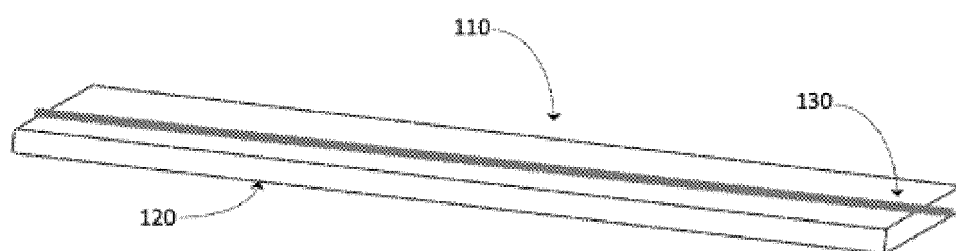


FIG. 3

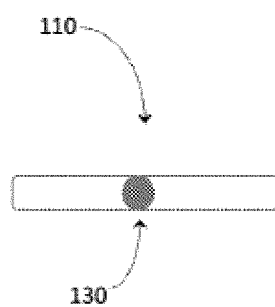


FIG. 4

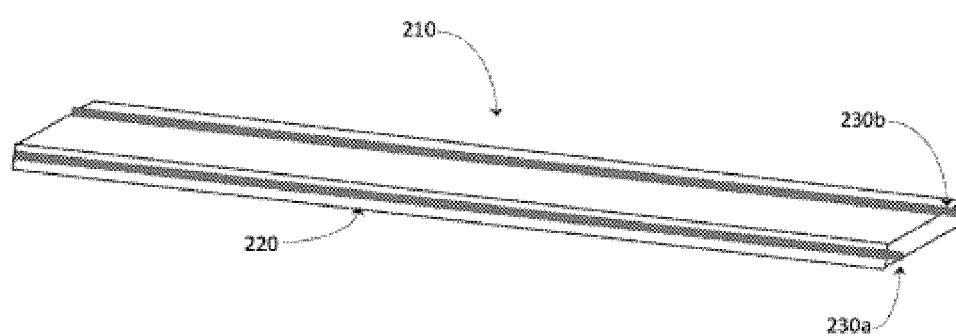


FIG. 5

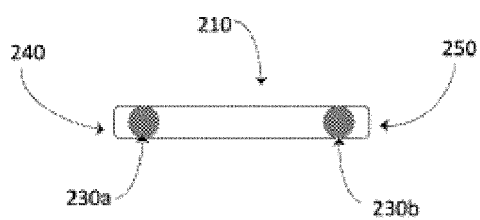


FIG. 6

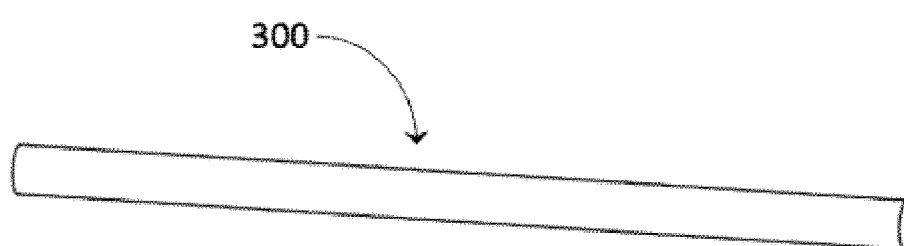


FIG. 7

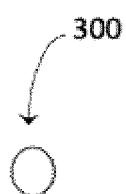


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CL2022/050008

A. CLASSIFICATION OF SUBJECT MATTER

(CIP) B65D33/30, B65D63/12, B65D75/00, C08G63/02, D01F6/14, D06M23/00 (2022.01)

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)

(CIP) B65D33/30, B65D63/12, B65D75/00, C08G63/02 (CPC) B65D63/10, D63/12, D75/00, D01F6/14, Y02W90/10

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)

Derwent, Esp@cenet, Patenscope, STNext, Google Patent, Google Scholar, INAPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CA424081 (A) (COLUMBIAN ROPE CO) 28-11-1944 See the whole document	1-4, 5, 7-8
X	US2936488 (A) (RHONE POULENC SA) 17-05-1960 See the whole document	1-4 y 8
X	DE1200471 (B) (KURASHIKI RAYON CO) 09-09-1965 See the whole document	1-4, 6, 7 y 8

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

14 Sept 2022

Date of mailing of the international search report

21 Sept 2022

Name and mailing address of the ISA/ INAPI,

Av. Libertador Bernardo O'Higgins 194,

Facsimile No.

Piso 17, Santiago, Chile

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CL2022/050008

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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