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(54) **METHOD FOR PRODUCING DURABLE BIODEGRADABLE MIXED YARNS, DEVICE FOR PRODUCING MIXED YARNS, AND MIXED YARNS OBTAINED USING SAID METHOD**

(57) The present invention relates to a process for producing mixed yarns comprising at least one spun yarn of natural or artificial fibres and at least one synthetic or artificial filament yarn. This process involves compressed air interlacing of mixed yarns in a technological process mounted and/or adapted on textile yarn spinning machines carried out inside an interlacing device that isolates the spun yarn and the filament yarn during the interlacing process, protecting the production line from oligomer molecules and loose fibres. The present invention allows a combination of different types of yarns that are biodegradable and/or contain recycled raw materials to be mixed together, making it possible to immediately take action and prevent the chemical pollution of textiles and textile fibres in the environment and especially in the oceans.

In addition, the present invention relates to mixed yarns derived from this process.

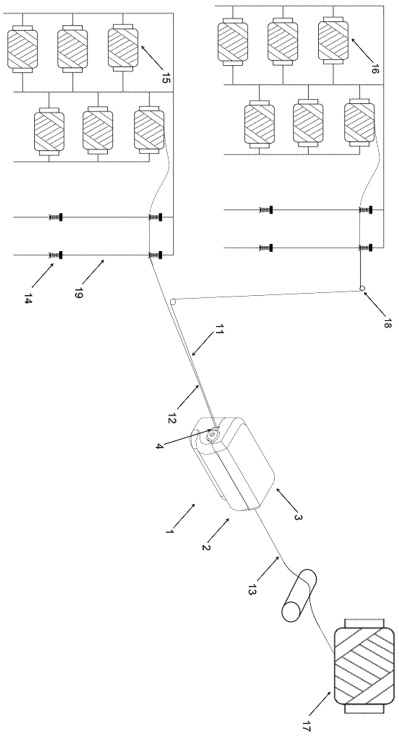

FIGURE 7

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Description

FIELD OF INVENTION

[0001] . The present invention relates to the technological sector of Textile Engineering and concerns a process for producing mixed yarns comprising at least one yarn spun from natural or artificial fibres and at least one air-textured or flat filament yarn being synthetic or artificial.

[0002] . In addition, the present invention relates to mixed yarns derived from this process.

BACKGROUND OF INVENTION

[0003] . Industrial spinning has been around since the mid-1800s and its processes remain the same as they were then. Opening the bales of fibres, cleaning the raw materials, parallelising the fibres, producing the rovings, producing the wick with a slight twist and finally the yarn with its specific twist, title, specific weight and specific composition for sale on the fashion-oriented textile market. What has changed since the 1800s is the speed of large-scale production and the automation of many stages in the process.

[0004] . There are only three types of processes for manufacturing and spinning natural and/or artificial fibres to become yarns for textile use: the ring spinning process, the rotor process and the vortex process (compressed air). The function of all these processes is to produce certain types of yarn on a large scale, a commercial commodity product.

[0005] . At this time of global warming and environmental pollution, we need to think about and manufacture durable products with more circularity between people using clothes made from biodegradable and/or chemically recycled materials, respecting the circularity of the product is essential at the current time in the modern textile industry after covid-19 and protection of our planet. The concepts of reusing raw materials and recycling them well have become more necessary and present in our daily lives.

[0006] . The need and duty to protect the environment from the massive overflow of oil-based raw materials from irregular processes in the textile chain, polluting and non-biodegradable and/or non-chemically recycled raw materials, is the new purpose of industries and consumers. The textile chain is complex and there is little communication between the beginning of the chain, relating to fibres and yarns - the soul of the garment, and the end of the chain being the direct sale of clothes in shops to consumers.

[0007] . Currently, traditional conventional blended yarn production processes use a mixer of natural and artificial fibres with synthetic cut fibres at the start of the process. The use of synthetic cut fibres mixed with natural and artificial fibres generates a great deal of pollution, as the synthetic cut or staple fibres easily come loose from the spun yarn in the products made during the production stages of conventional blended yarn (intimate Blend) and the fabric finishing stage, in the cutting and sewing stage in garment factories and during the use of clothes and domestic washing, thus increasing the dispersion of synthetic fibres and other petroleum-derived materials in the environment. Another problem is that the synthetic fibres that come loose during the production process of conventional mixed spun yarn (intimate blend) accumulate in the industry's machinery, generating the need to stop the machines to clean the synthetic fibres, losing useful time for uninterrupted chain production.

[0008] . In this sense, all the players in the textile industry chain must come together, collaborate and implement practices and solutions for sustainable, more durable and more circular processes and products that are easily biodegradable and/or chemically recycled in order to be economically integrated into their circular production and into the global textile market that is more chemically balanced and safer for the environment.

[0009] . Today, sustainable attributes add significant value to companies' assets. It is therefore a vector of interest for a number of reasons and can no longer be ignored or postponed.

[0010] . Below we highlight some of the state-of-the-art teachings on the subject:

[0011] . Document BR 10 2018 075494 7 describes a process for producing mixed yarns and mixed yarns obtained by coupling or adding or attaching spun yarns and cut fibre. This process uses compressed air injection with a pressure ranging from 0.5 to 8 Bar in order to enable the filaments to create interlacing points. It also operates at winding packing bobbin speeds ranging from 50 to 1200m/min.

[0012] . Document EP 0 161 572 describes a method for producing a mixed yarn of at least one false twist textured filament yarn made from synthetic thermoplastic material and at least one twisted staple fibre yarn made from natural cotton fibres with the application of air injection. This document indicates the use of elastomer or polyurethane yarn, for a better fixation of the yarns.

[0013] . Document EP 0 119 044 describes a process for the production of a partially orientated, synthetic, polymeric, continuous filament yarn with high shrinkage potential. This process results in an oriented fibre and necessarily applies a steam chamber.

[0014] . Document KR 100 725 042 describes with yarns made from synthetic fibre material which are produced by a process using a tray in a vacuum suction-type mixing unit and, at the same time, monofilament yarn material using

high-pressure air through feed rollers. This process necessarily involves heat treatment and a vacuum suction unit.

[0015] . Document KR 100 752 277 describes complex finished yarns comprising one or two or more synthetic fibre material yarns and one or two or more of the main natural fibres of short fibre material yarns are mixed complex finished yarns. In the process described in this document, a sequence of air tubes is used to provide these complex yarns.

[0016] . Document US 5,680,684 describes a method of air blending comprising: imparting a degree of blend to at least one synthetic yarn with another synthetic yarn; providing a series of signals with a fluctuation of 1/f; and varying the degree of blend imparted to the yarn corresponding to a varied strength of the series of signals with a fluctuation of 1/f. This document does not deal with mixed yarns (natural and artificial fibre).

[0017] . Document US 2016/0010246 describes a blended yarn comprising a continuous thermoplastic resin fibre and a continuous reinforcing fibre as fibre components, which has twist, the continuous reinforcing fibre being a carbon fibre and/or a glass fibre.

[0018] . Document US 6,564,438 describes a method for treating a composite continuous filament yarn: comprising an air jet yarn texturisation step and a yarn heating step.

[0019] . Document PI 0701681-6 discloses equipment for the production of mixed yarns comprising a rectangular piece preferably made of aluminium which includes a yarn guide preferably located in the upper front and left part, and in its central portion there are 3 pulleys of different diameters and axial to each other by means of the shaft; the first pulley feeds the equipment with the effect yarn (a), the second pulley determines the amount of effect yarn (a), the proportion of which can vary from 1% to 200%, and the third pulley feeds the equipment with the mixed yarn (b); two tubes intercept the piece perpendicularly through these tubes the primary yarns coming from the bobbin Rack enter the equipment; in the centre back of the rectangular piece there is a brake pulley and a bearing with two bearings. By means of weights, the nylon cord that semi-circles the third brake pulley paralyses the rotation of the pulleys.

[0020] . Document PI 0704157-8 discloses a process for producing mixed yarns comprising the interlacing of spun yarns with continuous filaments, based on the injection of compressed air at a pressure ranging from 3 to 10 Bar, which benefits the production of a mixed yarn.

[0021] . A problem that can be detected in the state of the art is that these mixed yarn production processes are applied to winding machine, where spun yarns from natural material or from natural and artificial blends via vortex, ring spinning machine and/or rotor are previously produced and require a new process applied to winding machine that are not interconnected in the main textile production chain (production of mixed yarns via vortex, ring spinning machine and rotor), and these spun yarns present on winding machines are interlaced to a virgin synthetic filament that is not recycled, let alone biodegradable, to become the final product.

[0022] . These processes entail storage costs and additional labour, as the stages of spinning the yarns and interlace them to the synthetic filament are not included in a single 'interconnected' process. In this way, the cost of producing durable and ecologically safe mixed yarns is high compared to processes that use the cut synthetic fibre blend (intimate blend) at the start of the process, discouraging the adoption of green technology and resulting in a greater quantity of less wash-resistant products.

[0023] . Another problem with the state of the art is that the fibres of the spun yarns and the oligomers are dispersed by the injection nozzle when the mixed yarns are interlaced, contaminating the entire production of mixed yarns and making it impossible to diversify the product compositions being manufactured simultaneously. In addition, this contamination of oligomers and dispersed fibres puts the safety of professionals on the mixed yarn production line at risk.

[0024] . Another problem is that the use of spring-loaded washers tensioners that apply a constant tension to different types of continuous filaments at high speed does not produce the right interlacing points in the final product yarn.

[0025] . Thus, a solution to these problems is provided by the present invention, through a production process for mixed yarns that can be easily incorporated into existing production lines, through a single and independent device (plug & play), which receives spun yarns from vortex, ring spinneret and rotor processes and interlace them to synthetic and/or artificial filament in a single main production flow, through concentrated jets of compressed air to create interlacing points, in which biodegradable and recycled continuous filaments have greater elongation, not requiring the use of spring-loaded washers tensioners and not requiring the use of a filament feeder.

[0026] . In addition, it is certified that this device operates in a closed container, reducing the dispersion of fibres in the air, which increases the operating time of the machines before they need to be cleaned, and avoids the contamination of the production line by fibres and oligomers, which makes it possible to produce yarns with different raw material compositions in the same physical space, giving more versatility to the factory floor.

[0027] . Therefore, there is no equivalent solution in the state of the art to the one presented here in the present invention, which combines technical differentials, economic advantages, environmental and sustainability attributes, safety and durability.

OBJECTIVES OF THE INVENTION

[0028] . Thus, it is an objective of the present invention to provide durable mixed yarns made from a combination of

at least one natural and/or artificial fibre and at least one compressed air textured and/or flat synthetic and/or artificial biodegradable and/or chemically recycled filament.

[0029] . Another objective of the present invention is to provide durable mixed yarns, preventing them from peeling and loosening fibres with environmental and circularity attributes.

[0030] . Another objective of the present invention is to provide a process for producing textile yarns that prevents chemical pollution of textiles and textile fibres in the environment and especially in the oceans, since it uses a lighter purging solution for cleaning, less use of baths for dyeing biodegradable and/or chemically recycled synthetic filaments, filaments that have already been dope-dyed and also prevents the release of natural and/or artificial fibres during the use and washing of clothes.

[0031] . It is another objective of the present invention to provide a process that can be (plug & play) into a technological process assembled and/or adapted in textile yarn interconnected spinning machines in a main production flow, relying on the protection of a container against fibre contamination in production.

[0032] . It is another of the objective of the present invention to provide rapid change of final count yarn, compositions and raw materials during production, without interrupting the operation of the entire process of spinning spun yarns.

[0033] . Another objective of the present invention is to provide a device that is compatible with automated processes for the production of mixed yarns, in line with global trends in Industry 4.0.

[0034] . Another objective of the present invention is to provide an automated process for the production of mixed yarns that can be controlled by artificial intelligence algorithms.

[0035] . Another objective of the present invention is to provide an automatically operating container that allows the process of interlacing the spun yarn and the synthetic filament to take place in a confined space, but which also allows automatic *yarn splicing by* automatically opening the container.

[0036] . Another objective of the present invention is to improve the exact quality of the raw material compositions of mixed yarns.

[0037] . Another objective of the present invention is to improve the process of spinning close-blend yarns by adding at least one air-texturised or flat filament and/or at least one natural and/or artificially spun yarn in the last stage of the process of the vortex yarns, rotor filament and ring filament of the winders that are interconnected to the process, creating a new hybrid of mixed yarns.

[0038] . It is another objective of the present invention to provide a device that facilitates rapid switching between the yarn and filament interlace process applied to the main interconnected production flow

[0039] . Another objective of the present invention is to prevent a large stock of mixed yarns and to lead the production of mixed yarns by interlacing spun yarn and filament applied to a secondary flow of mixed yarns produced in winding machine that are not interconnected to the process, using virgin raw materials that are easy to sell rather than a mixed yarn that is more specifically sold.

[0040] . Another objective of the present invention is to improve the process of spinning natural and artificial spun yarns by adding at least one recycled filament and/or one that contains part of the recycled raw material that is air-texturised or flat with nano-technology characteristics embedded in the internal molecules of the filaments, creating a new and wide range of comfortable and functional mixed yarns.

[0041] . Another objective of the present invention is to provide a process for producing mixed yarns that mitigates contamination of the production line by fibres and oligomers and offers greater safety for workers and the environment.

[0042] . Another objective of the present invention is to provide a more efficient and productive process and product as the filament is introduced at the end of the mixed yarn process, causing fewer breaks in the spun yarns and/or recycled spun yarns due to the resistance of the filaments, requiring less splicer action.

SUMMARY OF THE INVENTION

[0043] . The present invention achieves these and/or other objectives by means of a process for producing mixed yarns that comprises the following stages:

a) placing at least one continuous air-texturised or flat filament yarn through at least one tensioner;

b) placing at least one natural or artificial spun yarn through at least one tensioner, said at least one spun yarn coming from at least one winding machine and/or spun yarn process production machine;

c) placing at least one natural or artificially spun yarn to an entrance of an interlacing device;

d) placing at least one continuous synthetic or artificial filament air-texturised or flat to the said entrance of the interlacing device;

e) placing at least one continuous synthetic or artificial filament air-texturised or flat with at least one yarn spun through at least one compressed air nozzle;

f) injecting compressed air under the at least one continuous
filament with the at least one spun yarn in order to produce a mixed yarn through interlacement points between the

at least one continuous filament with the at least one spun yarn and removing a plurality of synthetic and artificial molecules and poorly attached natural and artificial fibres;
g) placing the mixed yarn through at least one packing winding bobbin.

[0044] . The present invention achieves these and/or other objectives by means of durable biodegradable and/or recycled mixed yarns obtainable by means of the above process.

[0045] . The present invention achieves these and/or other objectives by means of an interlacing device characterised by comprising:

- a container with rounded corners;

  said container comprising an entrance;
  and the closed container receives at least one spun yarn and at least one continuous filament from the same inlet;

- an interlaced mixed yarn outlet;
- at least one suction coupling orifice;
- a compressed air injection inlet orifice;
- an injector nozzle;
- a ceramic insert with a whirlwind creation orifice coupled to the nozzle;
- a lid; and

So:

when the device is activated, the nozzle injects a continuous jet of compressed air in such a way as to cause a whirlwind of air that interlace the capillaries of the continuous filament with the fibres of the yarn in such a way as to produce an interlaced yarn, which exits through the outlet and the said container protects the fibres and/or artificial or synthetic molecules from contaminating the production and the environment during the creation of the whirlwind; a suction element is connected to the suction coupling orifice in order to suck up the fibres contained in said container; and
the lid is automatically or manually controlled to open when the mixed yarn is broken.

DETAILED DESCRIPTION OF FIGURES

[0046] . The present invention is further detailed in the following figures:

. Figure 1 illustrates the basic configuration of the textile chain;
. Figure 2 illustrates: (a) Blending of natural and artificial fibres in the Opening stage; (b) Variation from end to end of the yarn. Long, fine fibres tend to move towards the centre of the yarn, while short fibres move towards its periphery;
. Figure 3 shows a diagram of a ring spinning process, rotor process and vortex process (compressed air);
. Figure 4 illustrates a schematic view of the production process and mixed yarns, with the spun yarn coming from a vortex filament process, according to a first realisation;
. Figure 5 illustrates a schematic view of the production process and mixed yarns, with the spun yarn coming from an *open end* filament process, according to a first realisation;
. Figure 6 illustrates a schematic view of the production process and mixed yarns, with the spun yarn coming from a ring spinning process, according to a first realisation;
. Figure 7 illustrates a schematic view of the production process and mixed yarns, with the spun yarn coming from a conical mill, according to a second realisation;
. Figure 8 illustrates the perspective view of the interlacing device for the production of open mixed yarns in a preferred embodiment;
. Figure 9 illustrates the bottom view of the interlacing device for the production of open mixed yarns in a preferred embodiment.
. Figure 10 illustrates the perspective view of the interlacing device for the production of closed mixed yarns in a preferred embodiment;
. Figure 11 illustrates the perspective view of the interlacing device for the production of mixed yarns, open and with the nozzle attached, in a preferred embodiment.
. Figure 12 illustrates the paths of the materials during the process of producing mixed yarns, with the process taking place with the device closed;
. Figure 13 illustrates the device closed and in operation during the mixed yarn production process,

. Figure 14 is an enlarged photo of the mixed yarns produced from the process of the present invention in the mixture of 30/1 Ne cotton spun yarn interwoven with 72/72 recycled polyester filament final yarn drawn and relaxed; and
. Figure 15 is an enlarged photo of multiple mixed yarns produced from the process of the present invention stretched;
. Figure 16 is an enlarged photo of a circular knit *jersey* fabric produced using a mixed yarn of the present invention with a dyeing effect of only the 50/1Ne viscose spun yarn.

DETAILED DESCRIPTION OF THE INVENTION

[0047] . The present invention relates to a process for the production of mixed yarns made from compressed air interlacing points, said process being able to be specially assembled and/or adapted to spun yarn machines in existing or future spinning mills. The process of the present invention uses compressed air textured filaments and/or flat filaments, all of which are artificial and/or synthetic, biodegradable and/or chemically recycled, interwoven with natural and/or artificial spun fibre yarns. Scientific studies carried out by the Senai Cetiqt textil institute in the city of Brusque/SC, number 2279/20 of February 2020, using the compressed air interlacing technique, have shown that prevention of natural and/or artificial spun fibre yarns helps to prevent peeling and breakage by reducing friction between the filaments, thus preventing fibre contamination caused by the breakage of filaments due to excessive friction between them. On the other hand, the filament better groups and holds the fibres of the spun yarn so that these fibres don't come loose easily, generating a more durable piece with better roundness and high quality use for hand drying shops.
[0048] . The invention presents a unique solution for automation in the production of mixed yarns, through a containerised device for automatic opening and closing in the event of a yarn break or other stoppages in the production flow.
[0049] . It is therefore a process that involves a new methodology for creating more durable and less polluting yarns for *fashion* textiles, technical fabrics, hospital, military and decorative fabrics with greater technological efficiency.
[0050] . The process of the present invention comprises the following steps:

a) conduct at least one continuous air-texturised or continuous flat filament 12 through at least one tensioner 14;
(b) driving at least one natural or artificial spun yarn 11 through at least one tensioner 14, said at least one spun yarn coming from at least one winding machine and/or from a machine for the production of spun yarn 11;
(c) guiding at least one natural or artificial spun yarn 11 to an inlet 04 of an interlacing device 01;
d) guide at least one continuous synthetic or artificial air-texturised or flat filament 12 to the said inlet 04 of the interlacing device 01;
e) arranging at least one continuous synthetic or artificial air-texturised or flat filament 12 with at least one spun yarn 11 through at least one compressed air nozzle 07;
f) injecting compressed air under the at least one continuous

filament 12 with the at least one spun yarn 11 in order to produce a mixed yarn 13 through interlacing points between the at least one continuous filament with the at least one spun yarn 11 and removing a plurality of synthetic and artificial molecules and poorly attached natural and artificial fibres;
. the injection of compressed air takes place inside a container 02 of said interlacing device 01, in which the fibres that come loose during injection and air from the injection nozzle 07 are sucked up by a central hoover attached to the coupling inlet orifice;

g) guiding the mixed yarn 13 through at least one winding packing bobbin 17.

[0051] . The mixed yarns 13, spun yarns 11 and continuous filament yarns 12 are guided at all stages by means of yarn guides and ceramic eyelets 18 with rounded ends, so as to minimise the chances of each yarn breaking.
[0052] . This process is illustrated in figures 4, 5 and 6.
[0053] . In a first embodiment, the process covered by the present invention comprises the spinning of natural or artificial fibre yarns spun on vortex, rotor and ring spinning machines. These spun yarns 11 can be received for the interlacing process from the respective vortex, rotor and ring spinning machines, or they can be adapted or interconnected directly in the last winding stage of the mixed yarn in the packing bobbin preparation, ready for use.
[0054] . This first realisation includes the following features:

i) first define the use of the end product mixed yarn in the textile chain. Define the raw material, thickness of the final mixed yarn (count yarn), breaking strength test, elongation test, interlacing points of the filaments, type of ceramic insert orifice from the nozzle, flatness of the filament, definition of biodegradable yarn, recycled yarn or if it contains recycled raw material of each yarn that will make up the mixed yarn type of finish that will be done on the fabric made with the final mixed yarn.

[0055] . Only then, inside the textile or spinning mill, remove at least one strand of filament from the continuous filament storage box 12 synthetic and/or artificial, biodegradable or recycled filaments to be sent to the bobbin rack, which should preferably be placed on the bobbin holders at an average distance from the nozzle of 5 metres or less.

[0056] . In addition, if the final mixed yarn product also contains another natural or artificial spun fibre yarn in addition to the one already being produced in the linked spinning process, this will be done. It should be noted that the major production requirement is to put at least one synthetic or artificial biodegradable continuous filament yarn into the spun yarn production process.

[0057] . Another advantage in relation to the final product is that the process of interlacing a spun yarn with a continuous filament carried out by device 01 generates interlacing points in which the space between the interlacing points is not exactly the same, generating a better visual appearance, which prevents the marking of uniform bars and lines on the fabrics, promoting a blending and uniformisation of yarns. This effect is generated by the inconsistencies in the nature of the union of a spun yarn and a filament.

[0058] . Preferably, the spun yarns 11 come directly from the spun yarn spinning line and are compatible with the most popular methods for spinning spun yarns: vortex (11a), rotor (11b) and ring spinning (11c). The continuous filament yarn with or without another spun yarn comes from the bobbin holders rack. Both yarns meet to be parallelised before entering the manual or automatic container and before entering the compressed air nozzle at a distance of 60cm to 10cm, depending on the machine to be used.

[0059] . ii) After placing at least one continuous filament yarn on the bobbin holder with or without a natural and/or artificial fibre yarn, they are passed through multiple ceramic yarn guides 18 and eyelets. The yarn guide 18 is used to guide the yarns through the interlacing process. They are then passed through multiple spring-loaded washers tensioners with ceramic plates. These spring-loaded washers tensioners 14 are extremely important so that the interlacing points are resistant between different raw materials and with the number of multiple yarns that contain the mixed yarn. Spring-loaded washers Tensioners can be automatic or manual. The procedure for adjusting the spring-loaded washers tensioners is already determined at the initial stage of testing and classifying the yarns that will make up the final mixed yarn product, depending on the strength and elongation ratio of the raw material used for the spun yarn 11 and the continuous filament air-textured yarn 12 with compressed air. The main observations were the elongation of the yarns, existing interlacing points and flatness.

Yarn Description	Resistance	Enlongment
PLA 76/32	184,63	19,80
PA 60 ECO Z	235,83	18,87
PA 60/60 OP AM ECO	211,08	23,89
PA 80/68 SOUL ECO	249,33	21,10
PA 44/34 TEXT. SOUL ECO Z	181,58	18,10
78/72 PES REC	306,25	15,87
75/36 T 400	163,00	11,02
50/72 PES ME REPREVE	195,41	16,40
40/1 CO APM COMPAC	221,75	2,50
30/1 CO	219,00	2,70
50/1 CO	175,41	2,37
40/1 LIOCEL	286,00	4,00
30/1 CV	228,33	7,25
PA 60/60	158,58	11,75
PA 44/34 6.6 Z	191,50	18,64
50/36 TEXT. PES	153,91	15,20
50/24 PES LISO	201,25	18,32
75/36 TEXT. PES	223,41	14,51

[0060] . Preferably, when the air-textured continuous filament 12 is biodegradable and/or recycled and has an elon-

gation greater than 15.70, the tensioners can be left loose without tension by passing through the centre orifice of spring-loaded washers tensioner 14 and with the light weight of the ceramic plates alone. This gives a specific tension of 0 gram-force from the tension-free starting point of the spring-loaded washers tensioners 14. Also, if the continuous filament 12 has an elongation of less than 15.70, it is preferable to apply 1 gram-force to the spring-loaded washers tensioners 14.

[0061] . If the spun yarn is natural or artificial, biodegradable and/or recycled, it is preferable for the tension applied to the spring-loaded washers tensioners to vary between 15 and 25 grams, depending on the elongation coefficient of the raw material chosen.

[0062] . However, when the yarn has an elongation below a certain value (most commonly found in natural and artificial spun yarns), the tension is regulated according to the raw material already stipulated in the process, for example:

[0063] . This tension, which is exerted on all the yarns, is important for the parallelisation of yarns with different raw materials at the entrance to the compressed air nozzle, where the more stretchness yarn will exert resistant interlacing points on the less stretchness yarns, balancing the difference in elongation between the different raw materials and enabling resistant interlacing points to be used in high-speed fabric machines without causing any visual defects and guaranteeing high fabric machine running efficiency.

[0064] . iii) the spun yarn 11 is led to a yarn interlacing device 01, through an inlet 04 of a container 02 and the continuous filament 12 is also led to the inlet 04 of said container 02, where the spun yarn 11 and the continuous filament 12 are interlaced.

[0065] . Referring to Figure 8, interlacing device 01 comprises a container 02 and a lid 03 with hinge 03a. Container 02 comprises a yarn inlet 04 and outlet 05, and an opening 06. The container also has the function of protecting the production line from oligomer and fibre contaminants that are dispersed during the compressed air jets that carry out the interlacing. Container 02 has a coupling orifice 08 to which an automatic central waste vacuum extraction device is coupled.

[0066] . In reference to Figure 9, a coupling inlet orifice 08 for coupling to a hoover line, and an air injection inlet orifice 09 for coupling an air compressor to an injection nozzle 07, as illustrated in Figure 11.

[0067] . In addition, lid 03 can be configured to open automatically.

[0068] . iv) The injection nozzle 07 usually changes the type of ceramic insert orifice that the compressed air is entering and forms a differentiated whirlwind that is stronger or less strong. This orifice, along with all the other stages, is also important in forming the interlacing points between yarns made from different raw materials. The choice of ceramic insert orifice depends on the final count yarn of the mixed yarn to be produced and the raw material. It is preferable to use the factor of the thickness of the mixed yarn count yarn; the thicker the yarn, the larger the orifice and the thinner, the smaller the orifice. Median count yarn between 60Ne and 20Ne result in the selection of a orifice that is widely commercialised on the market.

[0069] . In addition, container 02 can include a ceramic insert 10 with the function of creating the whirlwind for interlacing the yarns, and sensors for monitoring the quality of the yarn and the condition of the nozzle 07, as shown in Figures 11 and 12.

[0070] . It is also planned to realise additional coupling orifice on the side of the interlacing device, in which jets of compressed air are fired towards the nozzle 07 inside the interlacing device 01, with the function of cleaning the nozzle.

[0071] . An advantage of the present invention is that less mass of natural or artificial spun yarn needs to be used. In this way, the spun yarn is finer and has fewer short fibres on its periphery of the yarn, increasing the quality and durability of the yarns, for the production of a yarn of the same count yarn when compared to conventional 100% natural or artificial yarn. It also generates less fibre dispersion in the environment.

[0072] . In addition, the whirlwind formed by nozzle 07 is able to remove a multitude of molecules and poorly attached fibres, which are contained inside container 02 and are sucked up by the hoover connected to coupling orifice 08. As a result, the mixed yarn production process is not contaminated by process residues, reducing the frequency of machine cleaning and maintenance.

[0073] . In addition, lid 03 of container 02 allows the interlacing process to continue in the event of yarn breakage, or any situations in which both the spun yarn 11 and the continuous filament 12 need to be replaced in the nozzle 07 to resume the mixed yarn interlacing process.

[0074] . In addition, the automatic opening is configured to work in synchronisation with the yarn splicing elements of the machine itself used in vortex, ring spinning and rotor processes, for when there is a break in the mixed yarn. In this case, an automated arm captures the mixed yarn 13 produced, at the breaking point, and performs the movement of joining the breaking point of the yarn by moving its broken end to the splicer located before the interlacing device 01. With the automatic opening of lid 03 of container 02, the broken yarn is passed through nozzle 07 inside container 02, and the splice is made by the splicer before the entrance to Device (1) without the need for human assistance on automated machines, and the process of interlacing mixed yarn 13 can continue with a constant production flow, allowing the interlacing process to continue in the event of yarn breakage, or any situations in which both the spun yarn 11 and the continuous filament 12 need to be put back into the nozzle 07 to resume the mixed yarn interlacing process. This process can be carried out without compromising the visual and structural characteristics of the mixed yarn.

[0075] . When the interlacing device 01 is opened, suction through the suction coupling orifice 08 must be interrupted. This interruption can be made by a solenoid valve or similar.

[0076] . It is also possible to splice yarns when only one of the yarns breaks. In this case, the problem is that the mixed yarn produced will not have one of the yarns used as raw material. This change in the mixed yarn can be identified by optical sensors that indicate to the controller that the spun yarn or continuous filament yarn has been broken. In this way, an automated arm captures the poorly produced yarn on the packaging reel using a suction element and with the cutting units located on the automated arm and before the cutting unit. It performs suction and cutting at the top and bottom of the machine. Thus, a splice is made in the splicer and the process can be carried out without compromising the visual and structural characteristics of the mixed yarn.

[0077] . V) After the interlacing stitches have been made, the mixed yarn will be pulled by the machine's winding packing bobbin 17, which will wind the mixed yarn bobbin, ready for use.

[0078] . A second preferred embodiment of the process covered by the present invention, illustrated in figure 7, comprises spinning natural or artificial fibre spun yarns on a vortex, the rotor and ring spinning being adapted to or mounted on non-interconnected winding machine 16.

[0079] . This realisation is more costly because it has one more stage for preparing the mixed yarn compared to the first preferred realisation, but it can be very attractive for developing smaller-scale flexible manufacturing of new materials without spending a lot of resources, whereas the production of mixed yarns directly linked to the main spun yarn production process is more efficient, but has less adaptability compared to the process applied in non-linked winding bobbins machines.

[0080] . Preferably, the second realisation can be made in parallel to the first, in order to develop the market or meet specific demands for materials that are not being worked on in the first realisation, and can be easily adapted to the first realisation if large-scale production is required.

[0081] . The second preferred embodiment is very similar to the first with the following difference: the spun yarn does not come from the linked spinning process. In this case, both the plurality of continuous filament and the plurality of spun yarns come from the holders of the racks 19 not linked to the main production of spun yarn 11. In this realisation, the continuous filament 12 and the spun yarn 11 pass through tensioners 14 from the rack 19 and are passed through multiple ceramic yarn guides 18 (eyelets). The yarn guide 18 serves to direct the yarns through the interlacing process. They then pass through multiple spring-loaded washers tensioners with ceramic plates.

[0082] . Similar to the first realisation, the spun yarn 11 is led to inlet 04 of container 02 and the continuous filament 12 is led to said inlet 04 of said container 02, where the spun yarn 11 and the continuous filament 12 are interlaced by means of air injection.

[0083] . As a result of the process defined in both realisations, a mixed yarn production process is obtained that dispenses with the use of synthetic cut fibres in the initial stage of spun yarn production, which eliminates the dispersion of synthetic fibres in the machine environment. In addition, the final mixed yarn will not contain synthetic cut fibres, mitigating the release of possible synthetic fibres from filament breaks during fabric washing, promoting greater durability of the fabric and, consequently, of the garments, and preventing fibres from petroleum-based materials from contaminating the oceans and groundwater.

[0084] . Furthermore, one of the main differences in this process is the presence of container 02, which contains the raw materials during the yarn interlacing process. This container 02 completely isolates the nozzle 07 responsible for joining the spun yarn and the continuous filament, as shown in figures 10 and 12. The automatic hoover for textile waste such as oligomers and fibres, which is connected to the central hoover of each machine/equipment, is attached to the back of container 02, which is fixed to the machine and does not interfere with the opening and closing of automatic or manual container 02. With the hoover, there is no need to stop the machine spindle to clean the nozzle and the container walls. Only this function of vacuuming and depositing for correct waste disposal.

[0085] . Due to the high degree of automation of the process, it is possible to employ various modern control and automation techniques. Using industrial controllers such as PLCs and FPGAs, it is possible to set up an artificial intelligence algorithm to visually detect the condition and characteristics of the mixed yarn produced, and control the parameters of the main production or nozzle 07 to guarantee the final characteristics of the mixed yarn product.

[0086] . Interlacing device 01 can have sensing cameras inside or outside container 02 to monitor the process and the quality of the yarn. In this way, an algorithm controlled by artificial intelligence can be taught (from the term machine learning) to identify the structures of the mixed yarn, and thus have the controller issue commands to the various tanners on the production line, controlling the quality of the final mixed yarn in relation to a reference.

[0087] . In addition, the interlacing device 01 may contain a sensor for monitoring the state of the injector nozzle.

[0088] . For a perfect understanding of the present invention, some concepts and definitions will be presented below:

[0089] . Fibre should be understood as the unit of matter, characterised by its flexibility, fineness and high ratio between length and fineness, whose properties make it capable of being transformed into spun yarn. This definition also applies to determining the size of a natural fibre, synthetic or artificial fibre. Fibres cut or discontinued according to different cutting lengths, thus corresponding to the English term "staple", cut or discontinuous synthetic fibres are not part of the

present invention because they have already been scientifically analysed by several technical institutes. Synthetic staple fiber are one of the major causes of microfibre synthetic pollution in the oceans, a large part of which comes mainly from industrial products and processes containing cut or discontinuous synthetic fibres.

[0090] . The textile industry uses different types of fibres from the plant, animal and mineral kingdoms, as well as those that are chemically produced by man using materials from the plant and mineral kingdoms. Therefore, any material from the three kingdoms of nature that has the capacity to produce spun yarn is considered to be a staple fibre.

[0091] . As an example, figure 1 illustrates the textile industry chain.

[0092] . It is also important to define the physical properties of the fibres:

- Nature - Refers to its classification as a raw material. E.g. cotton, wool, silk, etc;
- Length is the dimension of the fibre in its natural state;
- Fineness is the measure of the fibre's diameter;
- Elongation is the maximum longitudinal strain the fibre can withstand before breaking;
- Elasticity is the ability of a fibre to recover, totally or partially, its initial length after the force that was deforming it has ceased;
- Morphology is the longitudinal view and cross-section that characterise the shape of the fibre;
- Porosity refers to the presence of pores in the fibre: the more porous the fibre, the more hygroscopic it is, i.e. the more it is able to absorb moisture and/or dye;
- Moisture is the percentage of water the material has in relation to its wet weight. "Regain is the percentage of water the material has in relation to its dry weight. Note: 0% regain is always greater than % moisture;
- Lustre is the natural shine of the fibre. The shape of the fibre also influences lustre. The smoother and rounder the fibre, the more lustre it has;
- Resilience is the property of fibres to return to their original state as soon as the load or force that compressed them is removed. Strength is the fibre's ability to withstand a load until it breaks;
- Density is the ratio between a fibre's mass and its volume;
- Flammability is the property of the fibre to burn or not;
- Flexibility is a fibre's ability to withstand bending;
- Reliability is a fibre's ability to turn into yarn;
- Colour is inherent to the nature of the fibre. In the case of natural fibres, colour variation depends on complex agronomic or livestock processes;
- Maturity is the degree of development of the fibre wall. For two fibres of the same diameter, the more mature fibre will be the one with the thicker wall in its cross section. This property only applies to natural fibres of vegetable origin, which for most fibres is closely linked to the time of harvest.

[0093] . It is also important to define the chemical properties of fibres. In this case, it can be said that they all refer to the behaviour of fibres when subjected to the action of acids, alkalis, oxidants or any other chemical treatments. From this point of view we can consider:

a) EFFECT OF ACIDS - Textile fibres are commonly subjected to acidic solutions. Depending on the concentration, temperature, time, etc., the behaviour of the different fibres varies. Generally, cellulose fibres are not resistant to acids, especially those of mineral origin, such as sulphuric acid;

b) EFFECT OF ALKALIS - Since ancient times, alkalising agents have been used for washing and bleaching textile products. Soap itself forms an alkaline solution in water. In general, and taking concentration into account, cellulose fibres resist alkalis better than acids;

c) EFFECT OF ORGANIC SOLVENTS - The somewhat recent introduction of dry cleaning has made the fibres' resistance to organic solvents important. Solvents such as carbon tetrachloride and trichloroethylene are often used to clean fabrics and their effect on the fibre is obviously important.

[0094] . The fibres also have biological properties, which are analysed technically in terms of the circular and sustainable nature of the textile industry:

- Insect resistance - The cellulose in plant fibres and the protein in animal fibres can serve as food for certain insects, such as moths, termites, etc;
- Resistance to Microorganisms - Cellulose is attacked by certain fungi and bacteria, which decompose it and use the deteriorated products as food. When textile materials are stored in a humid environment, they are often attacked by mould fungi.

[0095] . It is highly desirable that natural textile spun yarn fibres have a natural sustainable balance of planting and respect planting with and between/among different natural planted raw materials, creating a circularity of planting with other crops in the same soil and respecting the recovery time of nutrients, biodiversity and the soil itself:

- Planting, collecting and reallocating correctly with the local sustainability of each planted area;
- The use of electric or manual tools for planting, collecting and relocating, being refuelled by solar or wind power plants;
- not using pesticides, but using a natural aid against pests that is not harmful to the environment.

With regard to natural fibres:

[0096] . Cotton fibre: Pesticides are used in more than 95% of the world's cotton production, making them a major problem for this crop. Its productivity in terms of crops is estimated at 1,685 kilos of cotton lint per hectare. The world's annual production of cotton lint currently stands at 25 million tonnes. These figures reveal the pollution of pesticides being dumped on the ground, contaminating rivers and groundwater, dumping tonnes of pesticides into the oceans every day, already impacting the oceans by acidifying the waters and exterminating corals, destroying the life cycle of the oceans and damaging the algae in the production of oxygen that keeps the earth and living beings alive.

[0097] . Furthermore, since cotton is a natural plant that was chosen in the industrial revolution because of its economic interest for a few producers and because it is difficult to process compared to other natural fibres, it has reduced competition between producers, creating a huge economic interest around it and marketed on a large scale for a few.

[0098] . The need for a lot of water per hectare of land is a detrimental factor if cotton fibre is to be marketed on a large scale in times of climate change. 53% of cotton plantations are irrigated, which corresponds to 73% of production. The average consumption in this production is calculated at around 10,000 litres of water per kilo of fibre produced. The most widely used system is furrow flooding, which is considered less efficient. The drip technique can help reduce water consumption, for example: it is estimated that drip irrigation reduces the amount of water used by at least 16 to 30 per cent compared to flood or furrow systems, but even so water consumption is high.

[0099] . In Brazil, cotton from the field to the end product consumes an average of 2,33 thousand litres of water per kilo of fibre. And considering only the production cycle of the raw material, it's 1,700 litres per kilo of fibre produced. And considering that the estimated world population will be 10 billion people by 2050, cotton fibre will not become sustainable because there will be competition between drinking water consumption and planting for food. In addition to all these problems, cotton fibres processed in the textile industry carry many chemical agents that are harmful to the environment, specifically in soil; microorganisms are unable to feed on the broken cellulose molecule because of the barrier formed by chemical agents, textile cleaning products, bleaches, heat treatment, bactericidal or viral treatments. In addition, dyes, oils and other chemical agents used to process the fibre into clothing make it impossible for it to biodegrade in the soil.

[0100] . Still on the subject of cotton fibres, thousands of tonnes of fibres have been proven and seen around various depths and surfaces of the ocean. Its fibres are not biodegradable in salty environments. With all that has been said about cotton fibres and their processing in textile processes and their important role in the socio-economic outlook at this time in 2021, we need to reduce the use of impregnated chemical products and/or replace them with others, guaranteeing at least biodegradable cotton in the soil, using a minimum of water for organic and sustainable planting.

[0101] . Linen fibres are obtained from a natural source that brings sophistication, versatility and durability to the fashion textile market. However, it is a very expensive fibre economically. From planting to the preparation of the fibre and the final finishing of the fabric and garment, the impacts on the environment are minimal and almost non-existent. Its cultivation requires up to twenty times less water than cotton and minimal amounts of fertiliser. In addition, flax does not harm the soil and is easily incorporated into the rotation cycle along with other crops. Its fibres are processed with little use of electricity and with the help of natural agents such as rain and sun, without the use of pesticides and practically all the waste from its production is used by other industries such as cosmetics, food and paper. It is a very versatile fibre for a new green textile economy.

[0102] . Hemp fibres, like flax fibres, are obtained from a natural source that brings sophistication, versatility and durability to the fashion textile market. However, it is a very expensive fibre economically. From planting to the preparation of the fibre and the final finishing of the fabric and garment, the impacts on the environment are minimal and almost non-existent. Its cultivation requires no irrigation water compared to cotton, it doesn't need fertilisers, in addition, hemp doesn't harm the soil and is easily incorporated into the rotation cycle along with other crops, the processing of its fibres is done with little use of electricity and with the help of natural agents such as rain and sun, without the use of pesticides and practically all the waste from its production is used by other industries such as cosmetics, food and paper. A very versatile fibre for a new green textile economy.

[0103] . Banana fibres are obtained from a natural source that brings sophistication, versatility, durability and resistance to the fashion textile market and the technical industrial market, such as the production of organic surfboards. However,

this is a market with no industrial economic flow so far. From planting to the preparation of the fibre and the final finishing of the fabric and garment, the impact on the environment is non-existent. Its cultivation requires no irrigated water. In addition, the banana tree does not harm the soil, the processing of its fibres is done with little use of solar electricity and with the help of natural agents such as rain and sun, without the use of pesticides and practically all the waste from its production is used by other industries such as cosmetics, food and paper. A very versatile fibre for a new green textile economy.

[0104] . Natural silk fibre is a continuous protein thread. Since natural silk fibre is made up of two parts - fibroin and sericin - both can be analysed separately. Fibroin makes up 75-90% of the fibre and sericin 10-25%. There are also small traces of wax, fat and salts. Fibroin and sericin are similar compounds and are classified as protein.

[0105] . Animal wool fibre: fabric made from wool acts as a thermal insulator, doesn't get as hot in the sun (it keeps the body temperature on average 5 to 8 degrees lower than synthetic fabrics exposed to the sun), "breathes" on the body, is naturally elastic and therefore more comfortable and doesn't wrinkle. Wool is an animal fibre. Its average composition is as follows: Carbon - 50 per cent, Hydrogen - 7 per cent, Oxygen - 22 to 25 per cent, Nitrogen - 16 to 17 per cent, Sulphur - 2 to 4 per cent.

[0106] . Acetate fibre: acetate is a chemical textile fibre obtained from a chemical compound of cellulose. Its name is taken from one of the chemicals used: acetic acid. Acetate fibres should not be confused with viscose fibres, with which they were originally incorporated, mistakenly forming a single category. Their physical and chemical properties, as well as their reaction to dyes, are different from those of viscose.

[0107] . The artificial viscose fibre is mechanically processed: it does not require the use of water or polluting chemicals. The raw material for viscose comes from the cellulose of Eucalyptus trees, the Pinus family. It does not require irrigation to grow. It uses water from the local rainfall. Its soil also needs to be reclaimed for replanting. It does not need pesticides. A tree that grows quickly, reaching adulthood in 5 years and being used to make cellulose pulp.

[0108] . This mechanically processed cellulose generates an exceptional fibre for textile sustainability. It is a silkier and moister yarn. A fibre and yarn that is more comfortable to the touch. It is also a fibre that biodegrades more quickly in soil than cotton and/or other fibres and degrades 67% in saline environments in the oceans. It is an excellent fibre for outgrowing cotton and having a balance of sustainable planting and a circular market between the two species of raw material. It is also a strong candidate to take over the market from cotton and closed-chemical cycle artificial viscose fibre

[0109] . Artificial viscose fibre has a closed chemical cycle: it requires highly polluting chemical products to dilute the viscose and it is necessary to close the cycle and reprocess its by-products so that they can be sent to companies that need the material as a raw material and that also use it in a safe and closed way. The raw material for viscose comes from the cellulose of the Eucalyptus tree, the Pinus family. It does not require irrigation to grow. It uses water from the local rainfall. Its soil also needs to be reclaimed for replanting. It does not need pesticides. A tree that grows quickly, reaching adulthood in 5 years and being used to make cellulose pulp. Economically and commercially, this type of viscose yarn-making process exists on a large scale. It's a silky-touch yarn with a more moist feel. A fibre and yarn that is more comfortable to the touch. It is a fibre that biodegrades more quickly in soil than other natural and artificial fibres and degrades by 67% in saline environments in the oceans.

[0110] . An excellent fibre to grow economically for a greener, more circular economy and to create a balance of sustainable planting alongside cotton and a circular market between the two species of raw material.

[0111] . Closed chemical cycle artificial lyocell viscose fibre: requires far fewer chemicals to dilute the viscose. Fewer by-products for companies that need the material as a raw material and that also use it in a safe and closed way. The raw material for lyocell viscose comes from the cellulose of the Eucalyptus tree, the Pinus family. It does not require irrigation to grow. It uses water from the local rainfall. Its soil also needs to be reclaimed for replanting. It does not need pesticides. A tree that grows quickly, reaching adulthood in 5 years and being used to make cellulose pulp. Economically and commercially, this type of viscose yarn-making process exists on a large scale. It is a yarn with a very silky and moist feel. A fibre and yarn that is more comfortable to the touch. It is a fibre that biodegrades more quickly in the soil than other natural and artificial fibres and degrades 67% in saline environments in the oceans, according to a source in New Zealand. It is an excellent fibre to grow economically for a greener and more circular economy and to create a balance of sustainable planting alongside cotton and a circular market between the two species of raw material.

[0112] . Fermentation fibre from biological raw materials (brewed protein) with a closed chemical cycle and high fermentation pressure, requires much less or no chemical products for fermentation and can extract the cellulose to obtain discontinuous fibre or continuous filament. A growing product in Asia, very important for more sustainable circularity.

[0113] .

Types of traditional intimate blend in yarns:

[0114] . Traditional fibre blending is a major polluter during the manufacturing process of yarns, fabrics and garments and during the life cycle of the garment, releasing thousands of fibres randomly into the environment every day and

many of the compositions have fibres cut from polyester, polyamide and other synthetic fibres. Fibre blending is a traditional process in which fibres of different nature and/or properties are combined in terms of length, fineness, colour, etc. Fibre blends are nothing new, as they began to reveal their importance many years ago. The oldest fibre blend was created in England, consisting of 55% wool and 45% cotton. The aim was to obtain a fabric that was pleasant to the touch, light in weight, not felt-like and washable. A fabric specially made for hunting was initially a mixture of cotton and wool. Today, all the basic fabrics can be made from blends of fibres. There is no perfect fibre. All fibres have good, regular and poor characteristics. When the need arises for yarns or fabrics that have properties not found in a single fibre, the necessary combinations are made, so that the desired properties are added together, masking or minimising undesirable properties. Good blends require knowledge of science and the study of fibres, as well as a certain amount of creativity to meet the requirements of texture, colour, strength, comfort, durability, etc., characteristics that are numerous and varied, challenging the imagination of pattern makers and the tastes of consumers. These demands, tastes and flights of fancy dictate the objectives that mixtures must achieve. An example of how important it is to know the fibres to be mixed could be the initial modulus of elasticity, i.e. the relationship between stress and strain of the two fibres, which must be close. Nylon and cotton, for example, are not found in blends because the former has a low modulus, while the latter has a high modulus. This means that cotton would break and nylon would deform, depending on the stress applied. Therefore, blends, in addition to/as well as other factors, have to take into account modulus of elasticity, the fineness of the fibres needs to be approximate, etc. You could say that blends are made for various reasons:

- To create new colour effects on fabric and garments;
- To improve the efficiency of Spinning, Weaving and Finishing, obtaining a more uniform product;
- For economic reasons;
- To obtain better texture, handling and appearance for the fabric and garment;
- To obtain a fabric that performs better in terms of durability.

[0115] . A good example of blending fibres for better texture, performance, handling and durability. Levels of blends For a specific use, a blend of fibres, which complements the qualities of the other, should perform better than a fabric made with 100% of one of the component fibres. It is very difficult to generalise or specify in percentage terms, because the percentage varies with the species of fibre, its construction and the expected performance Textile Fibres. For example, a small amount of nylon (15 per cent) increases the strength of wool, but 60 per cent of the same nylon is needed to increase the strength of rayon. For the stability of a flat fabric, 50 per cent polyester mixed with wool is satisfactory, but 75 per cent is needed for a knitted fabric. Fibre manufacturers usually make recommendations and provide assistance to industries in order to maintain the good image of the performance of the fibre they produce on the market.

[0116] . Polyester is often mixed with cotton, wool, viscose, acetate, etc. The most common compositions are as follows: POLYESTER X COTTON, WOOL, etc 50% - 50% 55% - 45% 60% - 40% 65% - 35% 67% - 33% 80% - 20% 85% - 15% POLYESTER - COTTON 67% - 33% (*) (*) This mixture is widely used.

[0117] . Traditional blending can be: intimate, fibre blending, mechanical and yarn blending (twisting). Fibre blending in spinning can be carried out at any stage of the operation, for example at the opening and when passing through the draw frame. The nature of the fibres to be mixed determines the most appropriate place for mixing. Examples: polyester/cotton - at the draw frame Asbestos/viscose/ceramic - at the opening

[0118] . Figure 2 illustrates the following aspects in letters (a) and (b): In the case of cotton, the mixing of bales is of paramount importance for the good performance of the Spinning Mill, because it creates uniformity, helps to consume lower quality cotton and waste, as well as avoiding changes in machine settings, improving yields. Finally, table 1 below shows the properties of some fibres, based on which we can make mixtures to achieve certain results:

Properties	COTTON	RAYON	WOOL	ACETATE	NYLON	POLYESTER	ACRILIC	MODACRYLIC	OLEFINS
Volume and Compression Resistance	-	-	+++		-	-	+++	+++	
Shape Recovery	-	-	+++	++	++	+++	++	++	++
Shape Recovery after it gets wet	-	-	-	+	++	+++			
Absortion	+++	+++	+++	+	-	-	-	-	-
Static Resistance	+++	+++	++	+	+	-	+	+	++
Pilling Resistance	+++	+++	+	+++	+				++
Overall Resistance	++	+	+	+	+++	+++	+	+	+++
Abrasion Resistance ão	+	-	++	-	+++	+++	+	+	+++
Stability	++	-	-	+++	+++	+++	+++	+++	+++
Heat Resistance	+++	+++	++	++	+	+	++	-	-
+++	++ GOOD		+ REGULAR			- LACKING			

Manufacturing processes for textile spun yarns using natural and artificial fibres.

[0119] . Figure 3 illustrates a diagram of a ring spinning process, rotor process and vortex process (compressed air). The present invention is based on these processes with the addition of a step involving assembly and adaptation of the technology which will be described later.

[0120] . Each artificial and synthetic biodegradable continuous filament is textured with interlacing points made by a whirlwind of compressed air in its filaments as they pass through the air nozzle, known as compressed air texturing tangling or interlacing points in the continuous filament manufacturing process in the extruder.

[0121] . This textile process uses compressed air to manufacture a single continuous air-textured filament. It is a procedure to create more resistance, a pleasant touch and different textural effects in the final product. This process was developed to eliminate twisting processes between filaments and false twisting texturise between filaments. A faster and more economical way to air-texturise a filament and be able to warp it on flat and circular looms with optimum operating efficiency, eliminating various filament problems due to false twisting texturise that cause defects in the appearance of the fabric, the garment and the productivity and efficiency of the flat or circular loom. Mixed yarns that use this type of false-twist filament are rarely produced and are almost discontinued. It is still used by some people who have machines for a small and limited type of textile product. It has already caused and36 routinely caused serious problems in the production of fabrics on textile machines.

[0122] . The texturing of a single filament to create an *interlacing* stitch or points, has given rise to various terms such as *tangle lacing, tangling, entanglement, interlacing* and *comingling.*

Application of compressed air texturisation during filament spinning

[0123] . In continuous filament production, after spinning, the filaments are subjected to a jet of compressed air. This is a one-step process in filament extrusion spinning - passing through a air-texturising nozzle to create interlacing stitches on one filament only. It is recommended for the manufacture of low, medium or high interlacing biodegradable and/or recycled synthetic filament yarn and depends on the end product and the technical textile characteristics it is intended to confer on the textile product.

. Factors affecting the texturisation process

[0124] . The performance of the texturising process is generally assessed on the basis of stitch frequency, stability and stitch uniformity. There are factors that affect the properties of the mixed yarn and the factors are categorised as:

- Mixing jet parameters
- Machine parameters
- Yarn feeder parameters

[0125] . In the past and today, this technology is commercialised to produce large quantities of synthetic filaments and/or synthetic filaments with synthetic filaments and/or synthetic filaments interwoven with monofilament elastane at high speed and productivity. Raw materials that are neither biodegradable nor chemically recycled due to the fact that they contain elastane and with parameters that are very different from what is covered by the present invention and will be detailed below.

[0126] . Nano technological filaments greatly expand the possibilities of sensors with an Internet of Things function, making it possible to manufacture fabrics capable of analysing the human body in real time, for health monitoring, physical performance, early detection of diseases and even medical treatments.

[0127] . The electronic filaments built up until now have all been analogue - they carry a continuous optical or electrical signal. A digital fibre makes it possible to encode and process discrete bits of information - 0s and 1s - directly, greatly simplifying the design of so-called smart clothes.

[0128] . A fabric with the ability to store and process data digitally, adding a new dimension of information content to textiles and allowing fabrics to be literally programmed.

Digital filament

[0129] . The new filament was created by placing hundreds of silicon microelectrodes on a preform, which was then used to create a polymer filament from recycled chemicals. By precisely controlling the flow of the polymer, it was possible to create a filament with a continuous electrical connection between the microparticles over tens of metres.

Definition of the biodegradable and/or chemically recycled compressed air textured filaments comprised in the present invention

[0130] . There are different textured air-pressed filaments with three different interlacing points per linear metre:

- NIM low interlacing (0-10 stitches per metre)
- YES medium interlacing (40-50 stitches per metre)
- HIM high interlacing (100-200 stitches per metre)

Types of filament that are biodegradable and/or chemically recycled and/or contain recycled raw materials, such as bi-component filaments that combine raw materials from natural and synthetic sources in a single filament:

[0131] . Recycled polyethylene terephthalate, recycled polybutylene terephthalate, recycled polytrimethylene terephthalate Biodegradable polyester, biodegradable polyamide, recycled polyamide, biodegradable polylactic acid, biodegradable lyocell, biodegradable rayon, biodegradable acetate, filaments of fermented natural raw materials, filaments of/other natural animal or vegetable cellulose chains such as: milk, sugar cane, orange, spider web, mushroom, beetroot....

[0132] . The most commonly used filaments are recycled polyethylene terephthalate, biodegradable polyamide, recycled polyamide, biodegradable rayon and biodegradable and/or chemically recycled polylactic acid, polyhydroxyanate (PHA), polybutylene succinate (PBS) and lyocell filament.

[0133] . Within the universe of chemically air-textured biodegradable and/or recycled filaments, there are variations

in the fineness and number of filaments in the continuous filament: for example, polyester 50/36 Dtex. The number 50 is the fineness of the filament in DTEX and 36 is the number of filaments in the continuous filament.

[0134] . Among the air-textured filaments, there are also flat, untextured filaments with DTEX count yarn close to the textured yarns used in the present invention. In view of the above textile knowledge of what exists commercially, we can begin to understand exactly what the present invention is. In addition, the filaments can have various formats for specific textile functionalities, improving the productivity of our activities. For example, trilobal (star), cross, round or flat shapes.

[0135] . Thus, the purpose of the present invention is to combine the use of biodegradable and/or recycled filaments air-textured with compressed air or flat biodegradable and/or recycled filaments creating interlacing points between spun yarns from natural and artificial biodegradable fibres, by means of an air injection nozzle that performs a whirlwind of compressed air creating interlacing points near the final stage of yarn production in spinning mills. The final stage, the winding packaging bobbin 17 that prepare the mixed yarn bobbing that will be packaged and marketed to textile industries that make fabrics, clothing and textile accessories.

[0136] . The present invention has numerous technical and economic advantages when compared to the state of the art, some of which are listed below:

- the process for producing durable biodegradable and/or chemically recycled mixed yarns of the present invention uses continuous air-textured biodegradable and/or recycled filaments with the quantity of their inner filaments smaller, preferably up to the limit of their Dtex count yarn, for example 60/60 or 72/72 or 150/150. These scientifically proven biodegradable filaments are more resistant and break less with friction, and also have a pleasant feel on the skin for *fashion use,* with high prevention of microfibres that are generated by peeling or breakage of the internal filaments;
- the process of the present invention, by using biodegradable and/or chemically recycled compressed air-textured filaments, ensures that the natural and/or artificial fibres do not come loose so easily. The interlacing points of the air-textured filament guarantee greater durability for the natural and artificial fibres and, consequently, a more durable and circular garment.

[0137] . Scientific studies carried out by the Senai Cetiqt Textile Institute in the city of Brusque/SC (number 2279/20 - February 2020) show a lower average percentage of mass loss of natural and/or artificial spun yarn when compared to a product similar in weight and structure produced 100% with natural and/or artificial spun yarn. Validating that the path is not mono-materials but different materials mixed yarns by compressed air interlacing. The studies also show that only 4 synthetic fibres were found (with suspicion of cross-contamination), compared to a similar product found on the market today which releases around 5000 to 8000 fibres per wash, which validates this new mixed yarn process methodology proposed here.

- the process of the present invention uses biodegradable natural and/or artificial spun yarns, guaranteeing and delivering a lower coefficient of friction between the biodegradable and/or chemically recycled air textured filaments. Consequently, preventing peeling and filament breakage by preventing contamination of biodegradable artificial and/or synthetic filament fibres;
- the process of the present invention uses filaments that better group the natural and artificial fibres that are on the periphery and in the centre of the spun yarn. This variation occurs from end to end of the yarn. Long, fine fibres tend to move towards the centre of the yarn, while short fibres move towards its periphery. In this way, the filaments in the interlacing process better group the short and long fibres together, creating better protection against the fibres coming loose from the spun yarn;
- the process of the present invention uses mixed filaments with spun yarn to drastically reduce/or totally avoid the use of de-imaging oils placed on spun yarns. This generates a high cost for the product, more stages of insertion and removal of the product in the textile chain, pollution of the environment by textile effluents;
- the process of the present invention applies machine speeds compatible with large industrial processes without the need for expensive equipment adaptation, respecting the resistance condition of each material in order to produce the mixed yarn at high speed;
- the process of the present invention comprises an interlacing device 01 with a waste container 02 that can be cleaned without stopping the machine because it can be cleaned using an automatic suction system attached to all the containers;
- container 02 comprises a construction that completely isolates injection nozzle 07, ensuring that the fibres that come loose during the interweaving of the mixed yarn remain inside container 02, while at the same time being compatible with an automatic yarn splicer, allowing a loose yarn handler to return the broken yarn to the injection nozzle 07 by opening container lid 03 when the splicer starts operating and closing container lid 03 when the splicing is finished.
- the process of the present invention does not require heat treatment because it works with various different raw materials that can catch fire or spoil and damage the characteristics, structure and elasticity of some of the yarns in the final mixed yarn;

- The process of the present invention does not require a vacuum container because the fibres interlaced without the need for a vacuum and the compressed air used in the process needs to enter and be expelled;

[0138] . Heating in mixed yarns only in preparation for dyeing and finishing the yarns and/or fabrics to stabilise, properly elasticise, clean and dye the fabrics.

[0139] . The objectives and advantages of the process and product of the present invention are achieved by means of new scientific discoveries about the compressed air interlacing points between raw materials that are different from each other, preventing and protecting the oceans and the environment from the pollution of the fibres of the biodegradable and/or chemically recycled and durable mixed yarn itself. With the combination of specific biodegradable filaments and spun yarns, a new methodology is created to be implemented in the textile industrial chain of mixed biodegradable and/or chemically recycled yarns with greater power to quickly and creatively create products that are beneficial to society, less polluting and more durable yarns, using only biodegradable and/or chemically recycled filaments, ensuring greater safety for our eco-system, using higher speeds of spinning machinery being compatible with current packaging winding speeds on modern machines.

[0140] . The insertion of one or more filaments and/or spun yarn into the spinning process of the spinning machines without production contamination. The new 02 waste and/or fibre container with automatic suction system for this material without the need to stop for cleaning. The new methodology makes precise compositions of durable biodegradable and/or chemically recycled mixed yarns. The process of biodegradable and/or chemically recycled and durable mixed yarns does not use a large amount of oil, helping and preventing the cleaning of fabrics, called purging to remove impurities, so the need for a light purge helps sustainability in the use of water and prevents excessive spending.

- the process of the present invention does not use synthetic cut fibres or even any type of excess contaminating resin;
- the process of the present invention dispenses with the use of reinforcing yarns such as glass yarn and even elastane, elastomerised polyurethane yarns. This process uses several continuous compressed air-textured multifilament yarns that are biodegradable and/or recycled by consumption, mixed with other various types of spun yarns. Elastane is not biodegradable and is impossible to recycle for consumption. Older technologies use elastane with a false twist textured filament and only one type of count yarn cotton, the elastane being an important point in the interlacing points. These false twist textured filaments caused many warp defects, making it difficult to use these yarns in the warp of the flat loom, let alone on the needles of the circular loom, which could break all the needles, causing enormous damage. The inventors of the present invention have verified that it is not necessary to use elastanes to give strength to stitches where air-textured multifilaments with greater elasticity, such as biodegradable or recycled ones, are used.
- The process of the present invention does not use auxiliary feeders (traction motors), the feeders give different characteristics to the final product of the mixed yarn, causing an overfeeding of raw material over the other, they were created to use the mono filament of elastanes. This invention application uses only compressed air texturised filaments of any type of raw material;
- the yarns used in this process would be difficult to use in old conventional processes: biodegradable or recycled polyamide (would not work), PLA, PHA or PBS filaments which would be difficult to use in conventional processes because they are too elongated, rayon filament because it is too flat or acetate filament because it is too fragile and would not accept so much tension placed on it before interlacing.
- the product of the present invention transforms the market for *blended* synthetic and artificial cut fibres, marketed today on a large scale to mix different raw materials that are considered to be the greatest agent of contamination of the environment and oceans from textile micro-fibres, coming from the process and washing and manufacturing of clothes and their use in everyday life. This invention completely changes the way yarns are produced. It guarantees a better chemical and fibre balance between the end product and the environment, thus drastically reducing the polluting mass of fibres that come loose and contaminate the oceans or the environment, by hybriding mixed textile yarns using a biodegradable and/or chemically recycled filament with a natural and/or artificial spun yarn.
- Furthermore, the process of the present invention allows the use of nano-technological digital smart filaments that generate programmable and intelligent clothing in the near future by linking data. These filaments need to be continuous, resistant and protected. With the present invention, by means of mixtures of spun yarns, the digital filaments are protected against friction, providing greater durability and, in return, the filaments are able to mix with the spun yarns to make smart clothes;
- the product of the present invention (biodegradable and/or recycled filaments) with stretch are tension-free due to the technique developed by the inventors to be able to interlace and have other process purposes;
- The process has been perfected to allow the use of very different filaments. In addition, it can be used within a spinning mill without any contamination due to the help of the container and the suction and use of filaments;
- this process eliminates cut or synthetic staple fibres and reduces the use of natural and/or artificial staple fibres in the product, offering a product with durability for a circular economy.

Test results

[0141] . The table shows the wires tested:

Yarn Description	Category	Technical Specification	Composition
PLA 76/32	Biodegradable/Recycled	DTEX 89	100% PLA
PA 60 ECO Z	Biodegradable/Recycled	DTEX 58,6	100% PA
PA 60/60 OP AM ECO	Biodegradable/Recycled	DTEX 63	100% PA
PA 80/68 SOUL ECO	Biodegradable/Recycled	DTEX 85	100% PA
PA 44/34 TEXT. SOUL ECO Z	Biodegradable/Recycled	DTEX 40	100% PA
78/72 PES REC	Biodegradable/Recycled	DTEX 88,20	100% PES
75/36 T 400	Biodegradable/Recycled	DTEX 85,7	100% PES ELASTIC
50/72 PES ME REPREVE	Biodegradable/Recycled	DTEX 59,4	100% PES
40/1 CO APM COMPAC	Natural Spun Yarn	Ne 39,62	100% CO
30/1 CO	Natural Spun Yarn	Ne 29,49	100% CO
50/1 CO	Natural Spun Yarn	Ne 50,20	100% CO
40/1 LIOCEL	ArtificialYarn	Ne 40,57	100% LIOCEL
30/1 CV	ArtificialYarn	30,13	100% CV
PA 60/60	Conventional Yarns	DTEX 57,3	100% PA
PA 44/34 6,6 Z	Conventional Yarns	DTEX 46	100% PA
50/36 TEXT.PES	Conventional Yarns	DTEX 55	100% PES
50/24 PES LISO	Conventional Yarns	DTEX 59,1	100% PES
75/36 TEXT. PES	Conventional Yarns	DTEX 89,5	100% PES

[0142] . The table below shows the data achieved:

Yarn Description	CV% Resistency	CV% Enlongment	RKM
PLA 76/32	14,36	17,69	20,76
PA 60 ECO Z	2,72	9,23	40,23
PA 60/60 OP AM ECO	16,22	37,66	33,12
PA 80/68 SOUL ECO	25,88	50,99	29,2.2
PA 44/34 TEXT. SOUL ECO Z	5,88	12,98	42,81
78/72 PES REC	7,91	19,53	34,71
75136 T 400	28,85	46,16	19,29
50/72 PES ME REPREVE	12,7	23,62	32,89
40/1 CO APM COMPAC	11,33	26,71	14,87
30/1 CO	7,24	16,49	10,95
50/1 CO	9,03	35,56	14,91
40/1 LIOCEL	12,79	25,14	19,64
30/1 CV	5,64	14,07	11,65
PA 60/60	7,57	13,55	27,74
PA 44/34 6.6 Z	7,58	18,23	40,99

(continued)

Yarn Description	CV% Resistency	CV% Enlongment	RKM
50/36 TEXT. PES	10,3	13,47	27,62
50/24 PES LISO	6,23	16,39	34,04
75/36 TEXT. PES	25,77	35,33	24,96

[0143] . Result: there is a clear difference between the elongation of the biodegradable and recycled yarns covered by the present invention when compared to conventional yarns.

[0144] . As an example of a preferred realization of the present invention has been described, it is to be understood that the scope of the present invention covers other possible variations of the inventive concept described, being limited only by the content of the appended claims, including possible equivalents.

Claims

1. Process for producing mixed yarns (13) from at least one spun yarn (11) and one continuous filament yarn (12) **characterized by** the following steps:

   a) lead at least one continuous filament yarn (12) through at least one tensioner (14);
   b) conducting at least one spun yarn (11) through at least one tensioner (14);
   (c) guiding at least one spun yarn (11) to an inlet (4) of an interlacement device (1);
   d) guide at least one continuous filament (12) to the said inlet (4) of the interlacement device (1);
   e) arrange at least one continuous filament (12) with at least one spun yarn (11) through at least one compressed air nozzle (7);
   f) injecting compressed air under the at least one continuous
   filament (12) with the at least one spun yarn (11) in order to produce a mixed yarn (13) through interlacement points between the at least one continuous filament with the at least one spun yarn (11) and removing a plurality of synthetic and artificial molecules and natural and artificial fibres poorly attached;
   with the injection of compressed air taking place inside a container (2) of the said interlacement device (1), in which the fibres that come loose during injection and air from the injection nozzle (7) are sucked up by a central aspirator coupled to the coupling inlet orifice (8); and
   g) guiding the mixed yarn (13) through at least one winding packing bobbin (17).

2. Process according to claim 1 **characterized by** said continuous filament yarns (12) are flat or compressed air textured, being made from biodegradable materials or containing recycled raw materials selected from the group consisting of recycled polyethylene terephthalate, recycled polybutylene terephthalate, recycled polytrimethylene terephthalate, biodegradable polyester, biodegradable polyacid plastic, biodegradable polyamide, recycled polyamide, biodegradable lyocell, biodegradable rayon, microbial cellulose, polyhydroxyalkanoate (PHA), polybutylene succinate (PBS), cow dung cellulose, mushroom mycelium, animal cellulose, vegetable cellulose, fruit protein, fermented cellulose protein.

3. Process according to claims 1 and 2, **characterized by** said spun yarns (11) are yarns spun from natural and/or artificial fibres, using at least one spun yarn spinning process among: vortex spinning, ring spinning or rotor spinning.

4. Process according to claims 1 to 3, **characterized by** prior to the production process of mixed yarns (13), said continuous filament yarns (12) are arranged in bobbins rack holders (19) and said spun yarns (11) come from the spinning process of spun yarn among: vortex, ring or rotor.

5. Process according to claims 1 to 3, **characterized by** prior to the production process of mixed yarns (13), said continuous filament yarns (12) are arranged in bobbins holders (19) of the rack and said spun yarns (11) are also arranged in bobbins holders (19) of a rack.

6. Process according to claim 1 to 5 **characterized by** the spun yarns further comprise at least one biodegradable spun yarn selected from the group consisting of biodegradable cotton, biodegradable organic cotton, biodegradable viscose, biodegradable lyocell and biodegradable hemp, biodegradable flax, biodegradable wool, fermented cellu-

losic protein and other fibres from renewable raw materials sourced from nature.

7. Process according to any one of claims 1 to 6 **characterized by** the resulting mixed yarns (13) comprise interlacement points with natural and artificial biodegradable spun fibre yarns.

8. Process according to any one of claims 1 to 7 **characterized by** the plurality of mixed yarns (13) comprise at least one natural and/or artificial fibre and at least one synthetic or artificial filament.

9. Process according to any one of claims 1 to 8 **characterized by** when the mixed yarn (13) breaks, the process comprises the following additional steps:

- interrupt the suction of the central hoover attached to the coupling inlet (8);
- Air jet firing to clean injector nozzles (7);
- opening the lid (3) of the container (2);
- capture of the mixed yarn (13) broken by a suction paddle;
- movement of the loose end of the mixed yarn (13) in order to join the breaking point of the yarn by moving its broken end to the yarn splicer located before the interlacement device (1), with the broken mixed yarn being passed through the nozzle (7) inside the container (2);
- realisation of the splice between the broken mixed yarn and the continuous filament yarns and spun yarn before the entrance to the interlacement device (1), by means of an air jet;
- closing the lid (3);
- resuming the mixed yarn production process; and
- resume suction from the central hoover attached to the coupling inlet (8).

10. Process according to any of claims 1 to 8 **characterized by** is automatic, the actuators being controlled by a programmable logic controller.

11. Process according to claim 10 **characterized by** being controlled by an artificial intelligence algorithm through visual detection of the condition and characteristics of the mixed yarn produced, in order to control the parameters of the main production or the nozzle (7) based on a reference signal.

12. interlacement device (1) of at least one continuous filament (12) and a spun yarn (11) **characterized by** comprising:

- a container (2) with rounded internal corners;

  said container (2) comprising an inlet (4) an opening (6), an opening lid (3) and a mixed yarn outlet (5);
  with said closed container (2), receiving at least one continuous filament (12) and/or at least one spun yarn (11) through the same inlet (4);

- at least one suction coupling orifice (8);
- a compressed air injection inlet port (9) and
- an injector nozzle (7);

wherein:

when the device is activated, the nozzle (7) injects a jet of compressed air so as to cause a whirlwind of air that interlace the capillaries of the continuous filament with the fibres of the yarn so as to produce an interlacement mixed yarn (13), which exits through the outlet (5) and said container (2) contains the plurality of fibres and/or artificial or synthetic molecules that are removed from the yarns during the creation of the interlacement points; and
a suction element is connected to the suction coupling orifice in order to suck up the fibres contained in the container.

13. Device (1) according to claim 12, **characterized by** further comprises a ceramic insert (10) with a whirlwind creation orifice coupled to said nozzle (7).

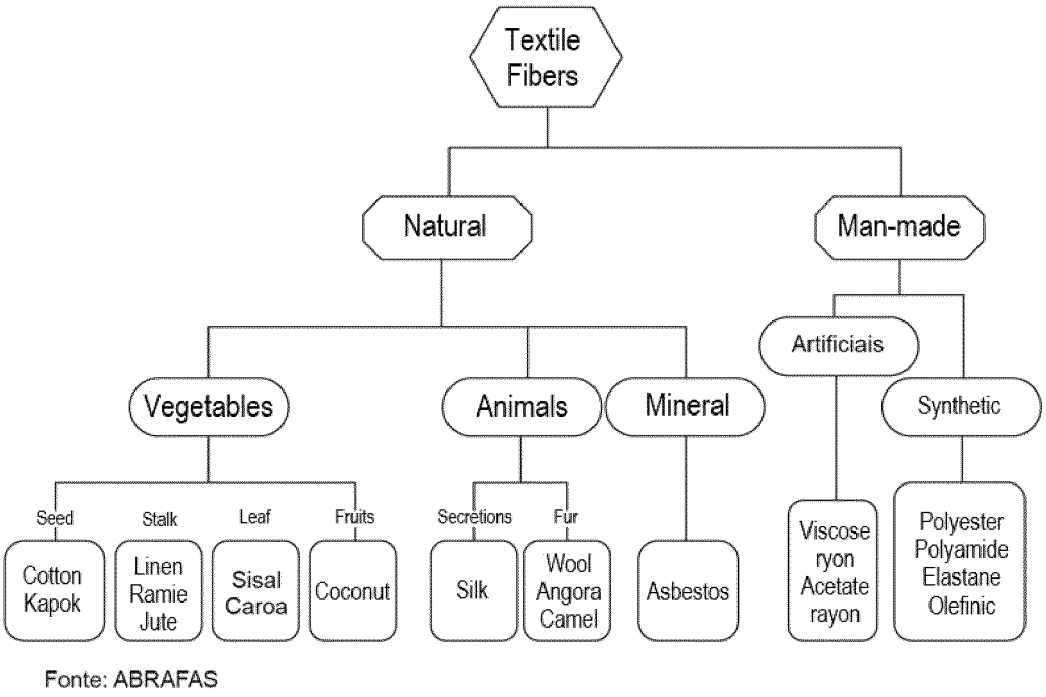
14. Device (1) according to claim 13, **characterized by** the lid (3) is controlled manually or by a motor to open the container (2) in a yarn splicing operation.

15. Device (1) according to claims 13 and 14, **characterized by** comprising at least one optical sensor configured to monitor the yarns structure and/or the state of the injector nozzle (7).

16. Durable biodegradable and/or recycled mixed yarns **characterized by** being obtainable by means of the process as defined in any one of claims 1 to 11.

17. Durable biodegradable and/or recycled mixed yarns according to claim 15 **characterized by** comprising at least one natural or artificial spun yarn and at least one synthetic or artificial filament.

18. Article of clothing **characterized by** comprising durable biodegradable and/or recycled mixed yarns as defined in claim 16 or 17.



Fonte: ABRAFAS

FIGURE 1A

Basic Configuration of the Textile Production Chain

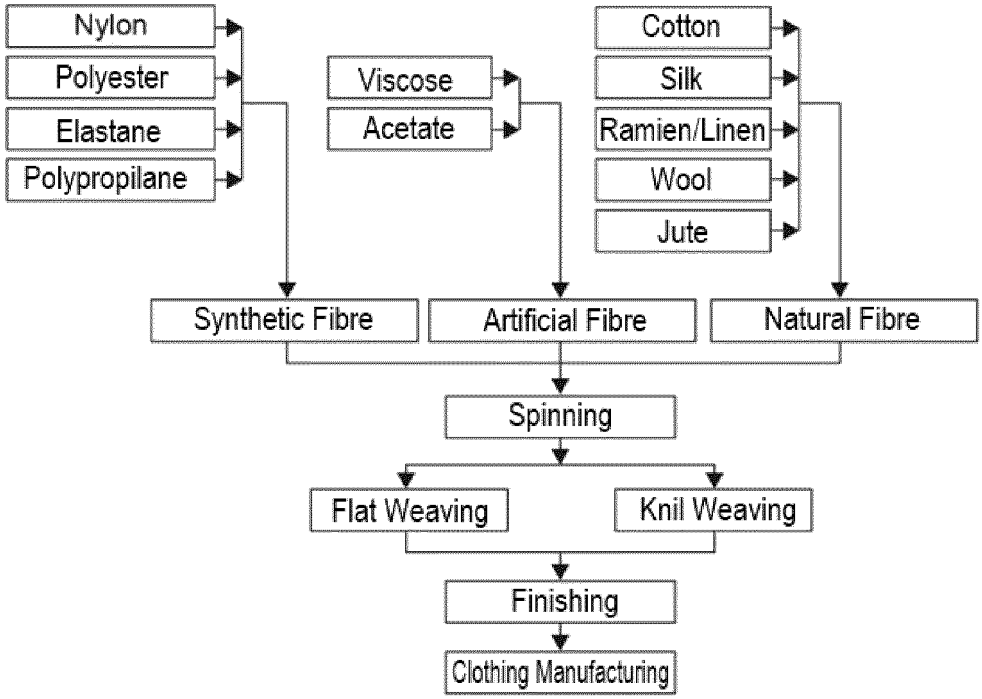


FIGURE 1B

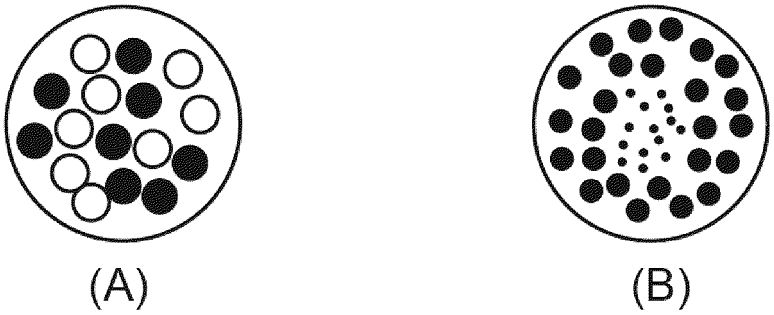


FIGURE 2

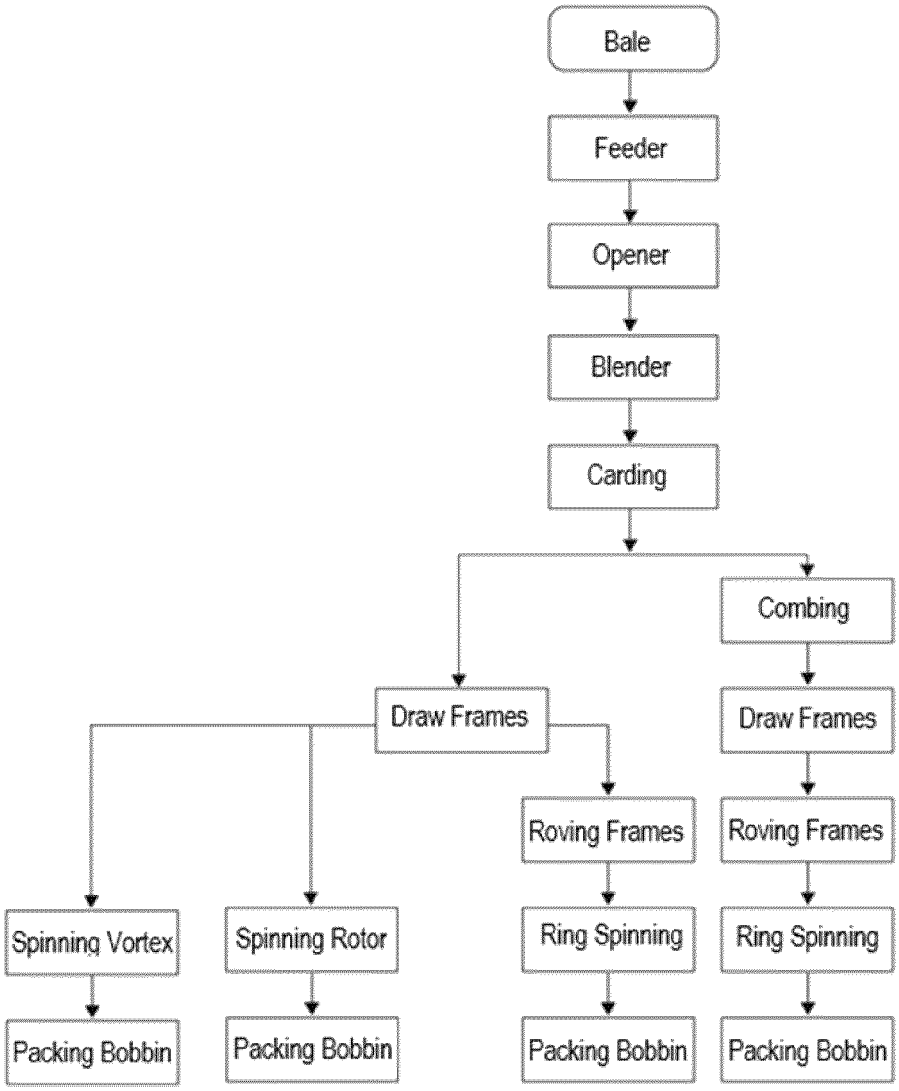

Bale
Feeder
Opener
Blender
Carding
Combing
Draw Frames
Draw Frames
Roving Frames
Roving Frames
Spinning Vortex
Spinning Rotor
Ring Spinning
Ring Spinning
Packing Bobbin
Packing Bobbin
Packing Bobbin
Packing Bobbin

FIGURE 3

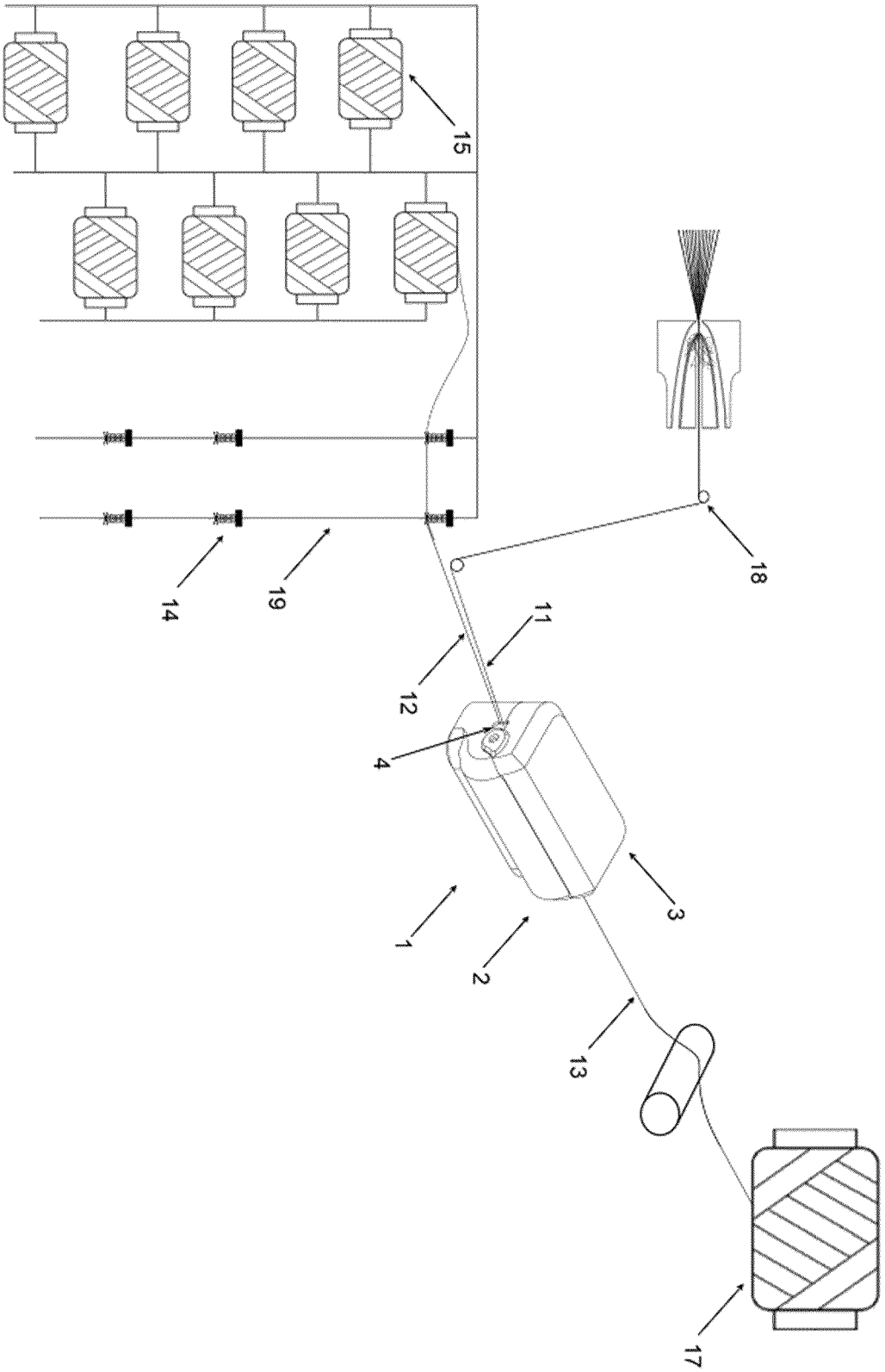


FIGURE 4

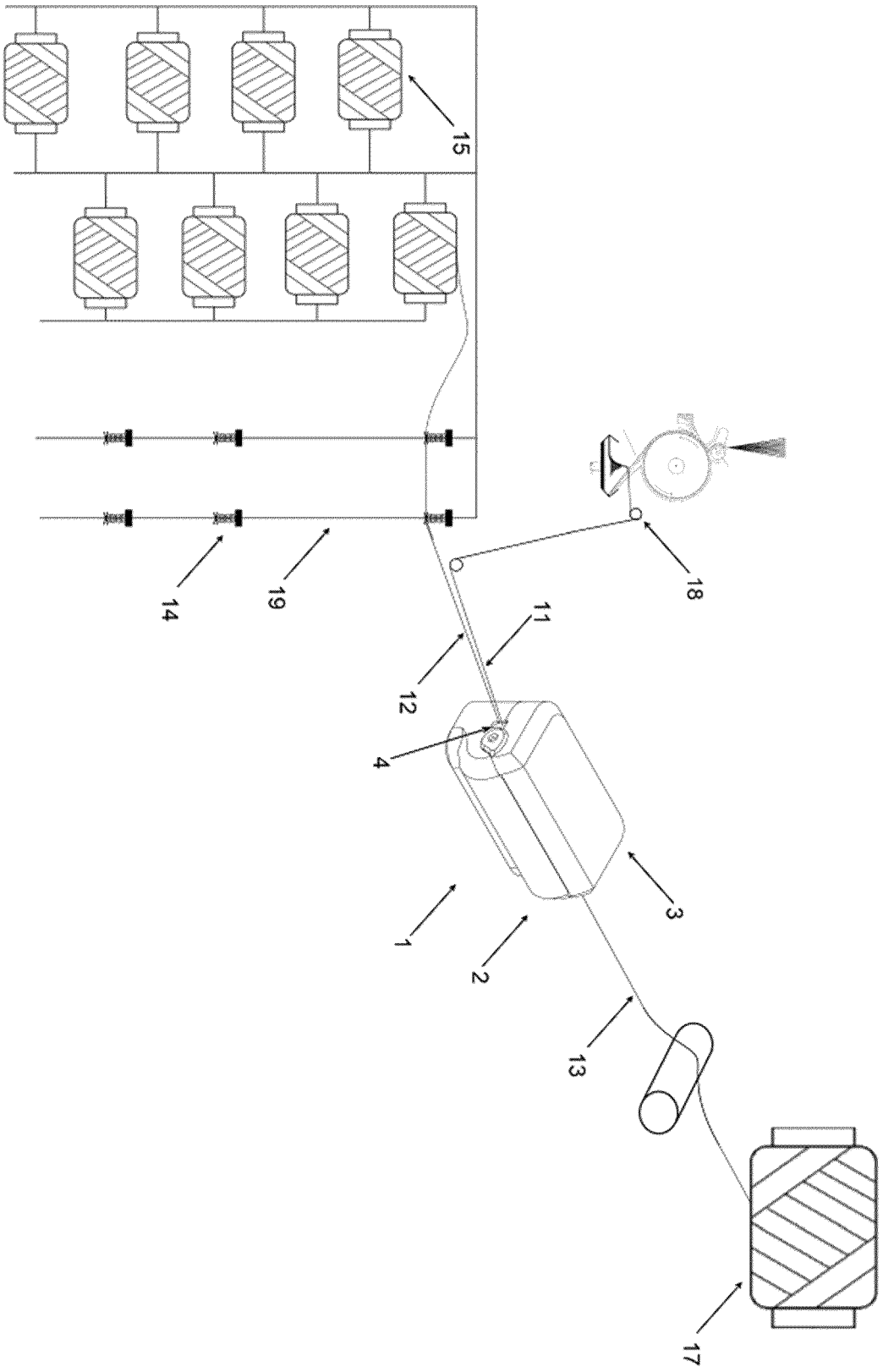


FIGURE 5

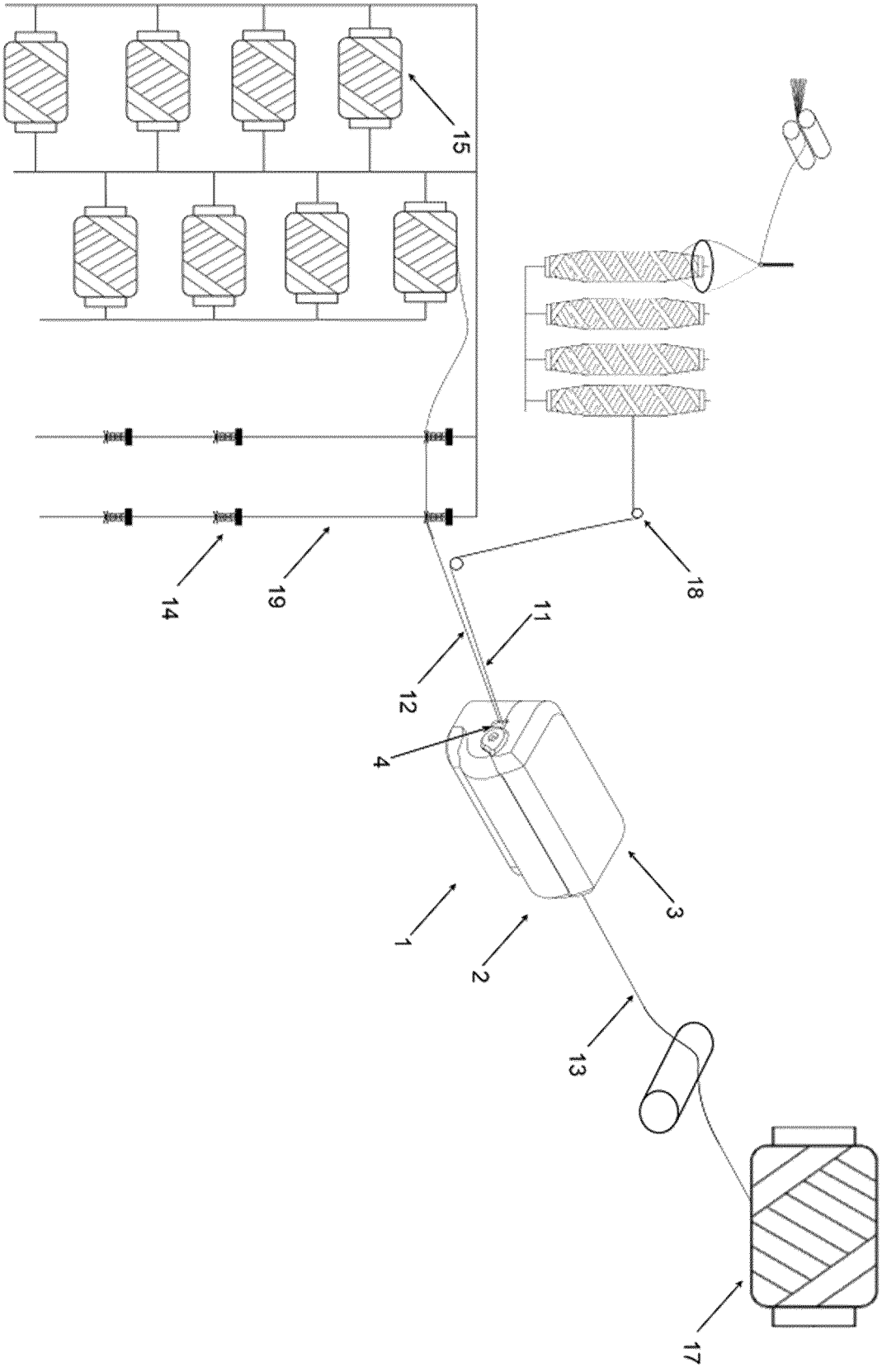


FIGURE 6

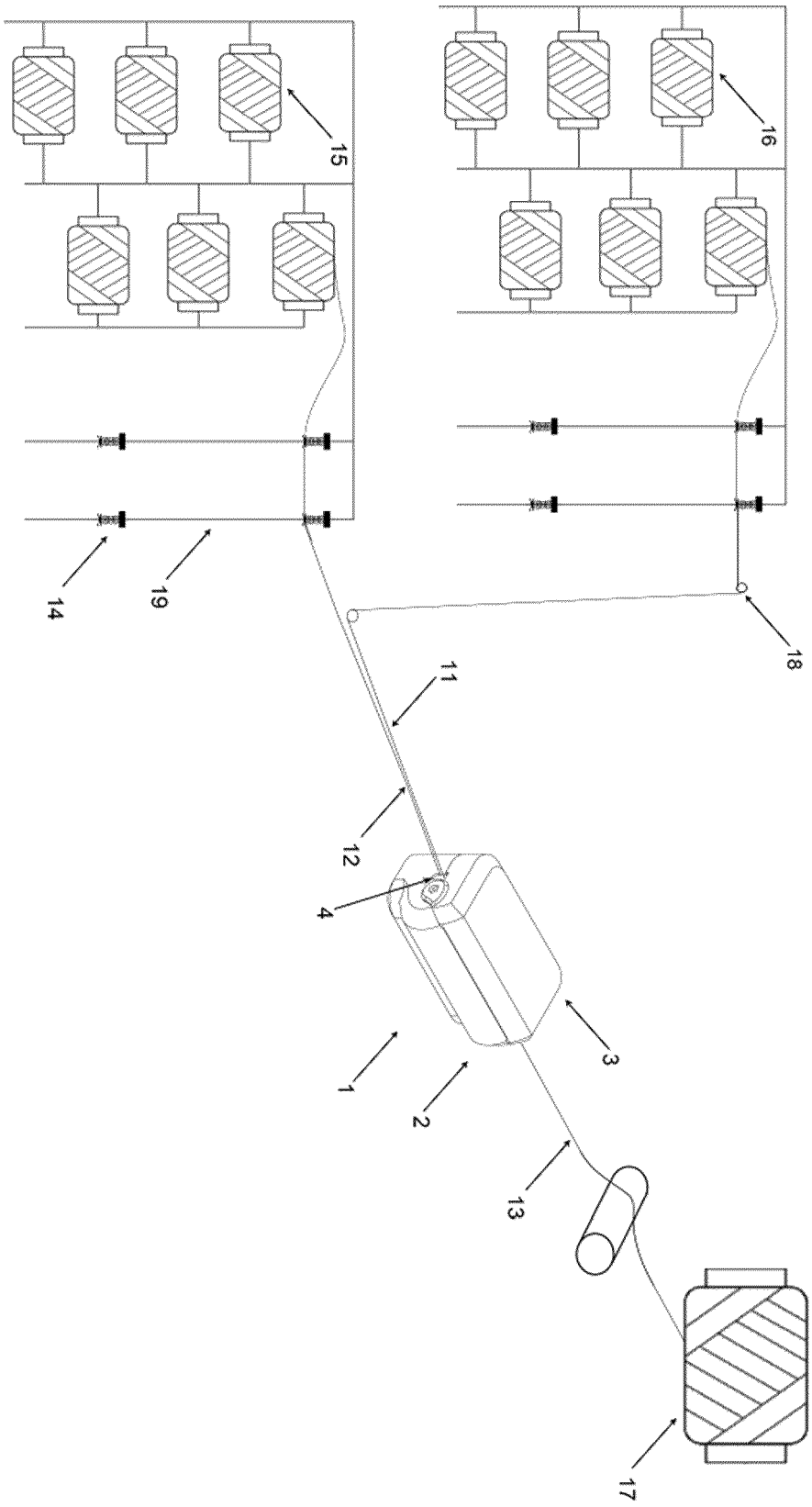


FIGURE 7

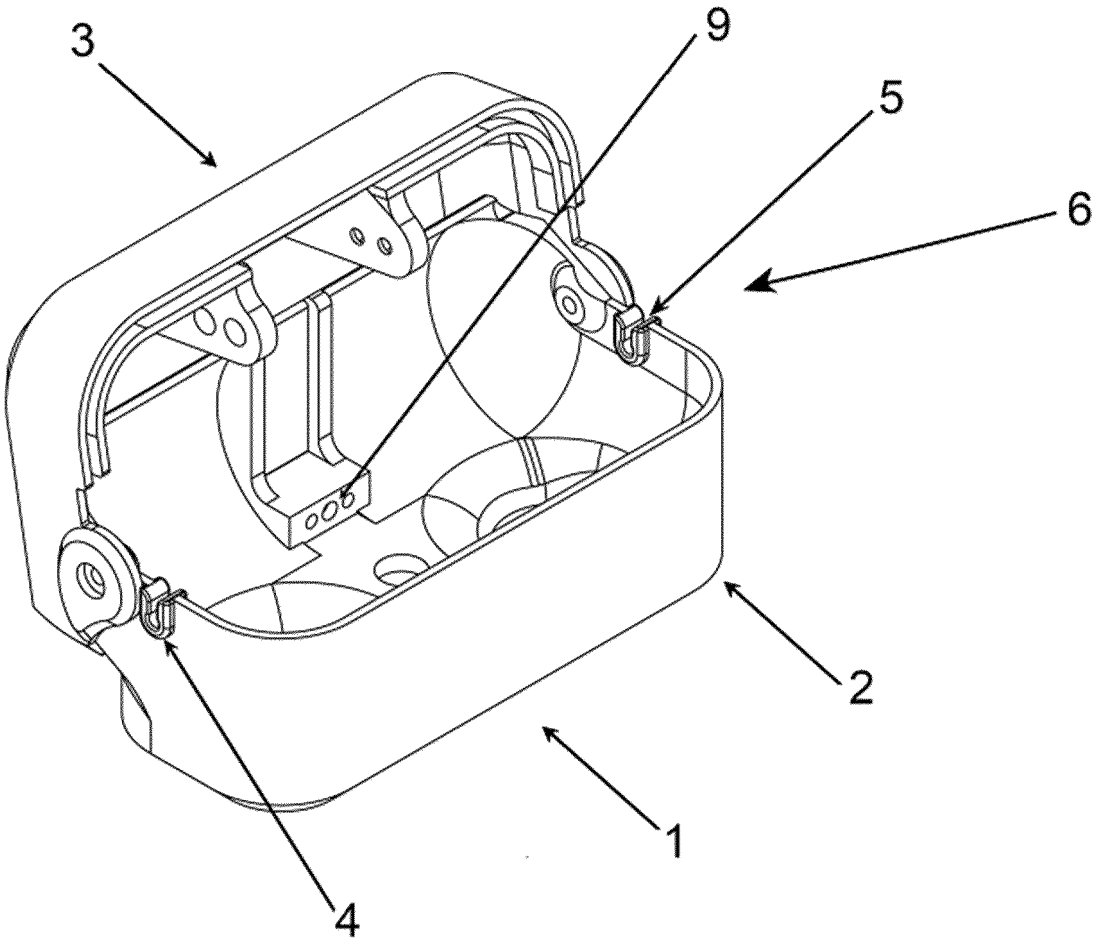


FIGURE 8

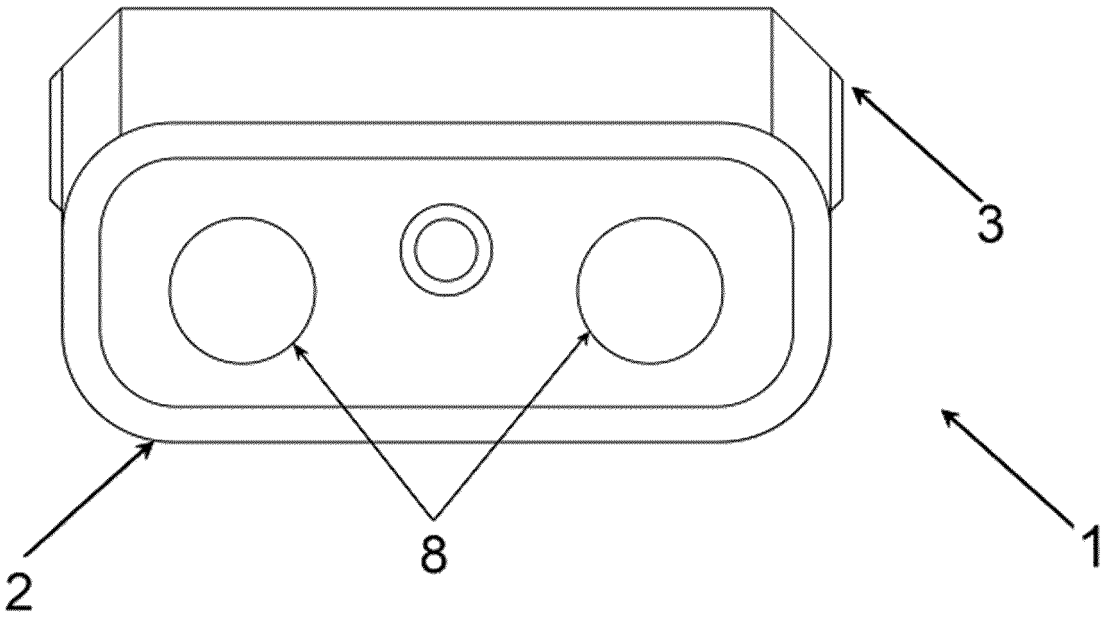


FIGURE 9

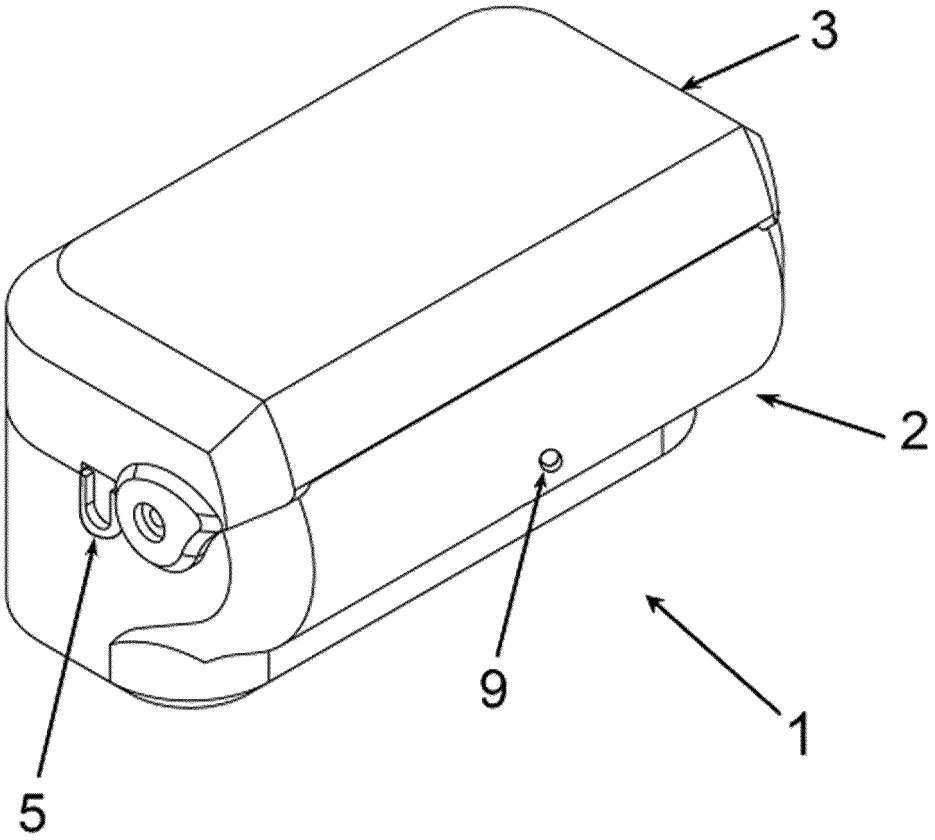


FIGURE 10

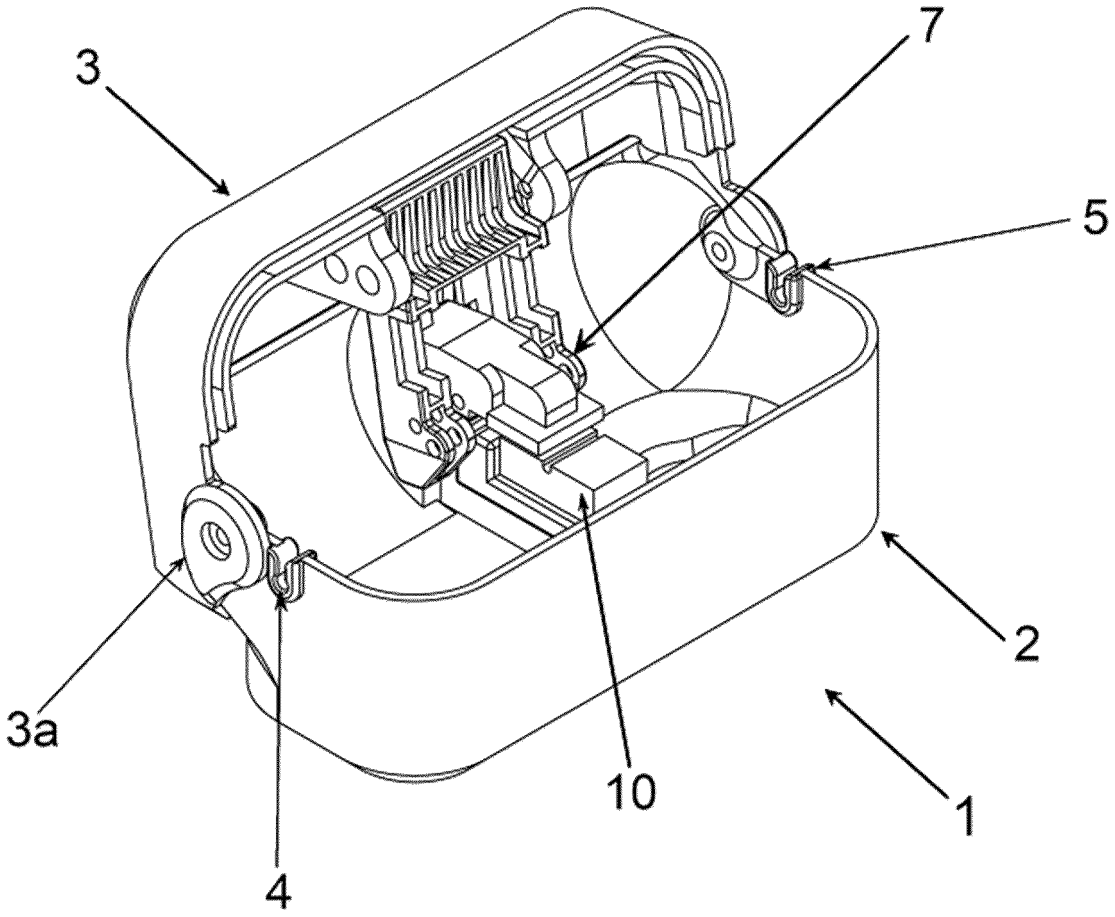


FIGURE 11

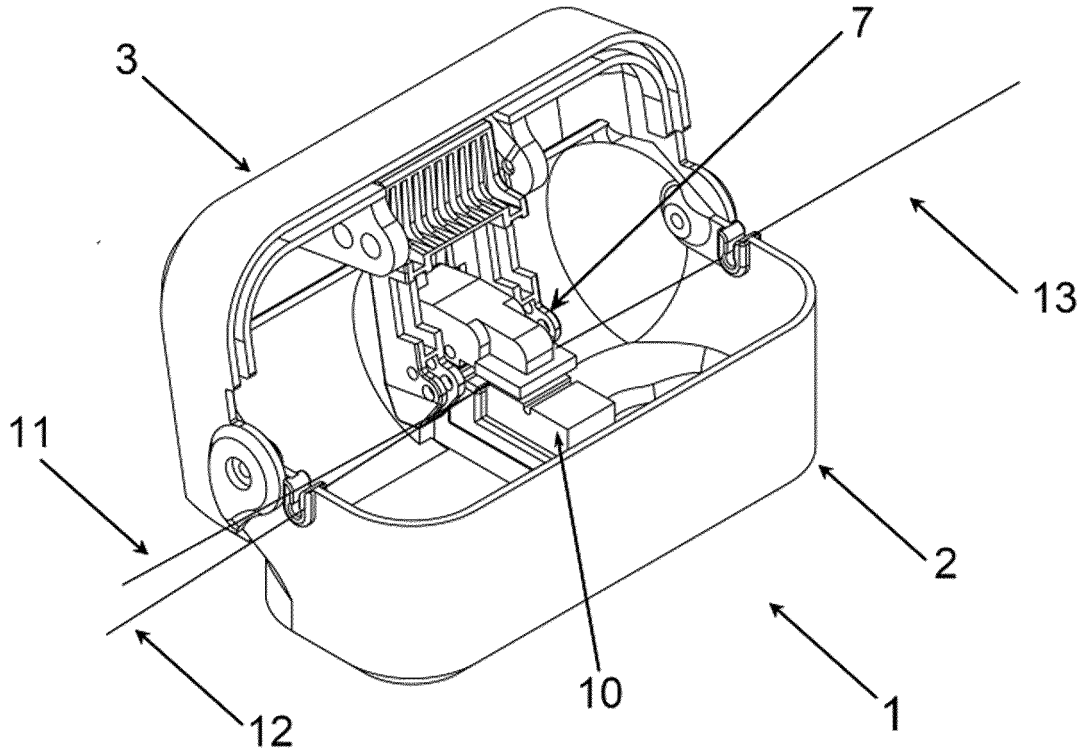


FIGURE 12

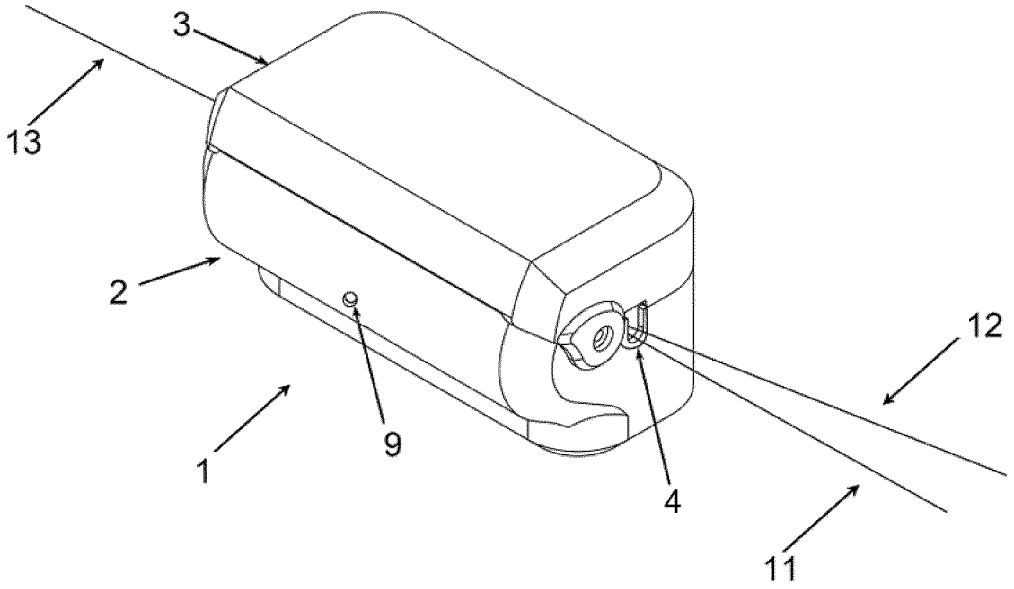


FIGURE 13

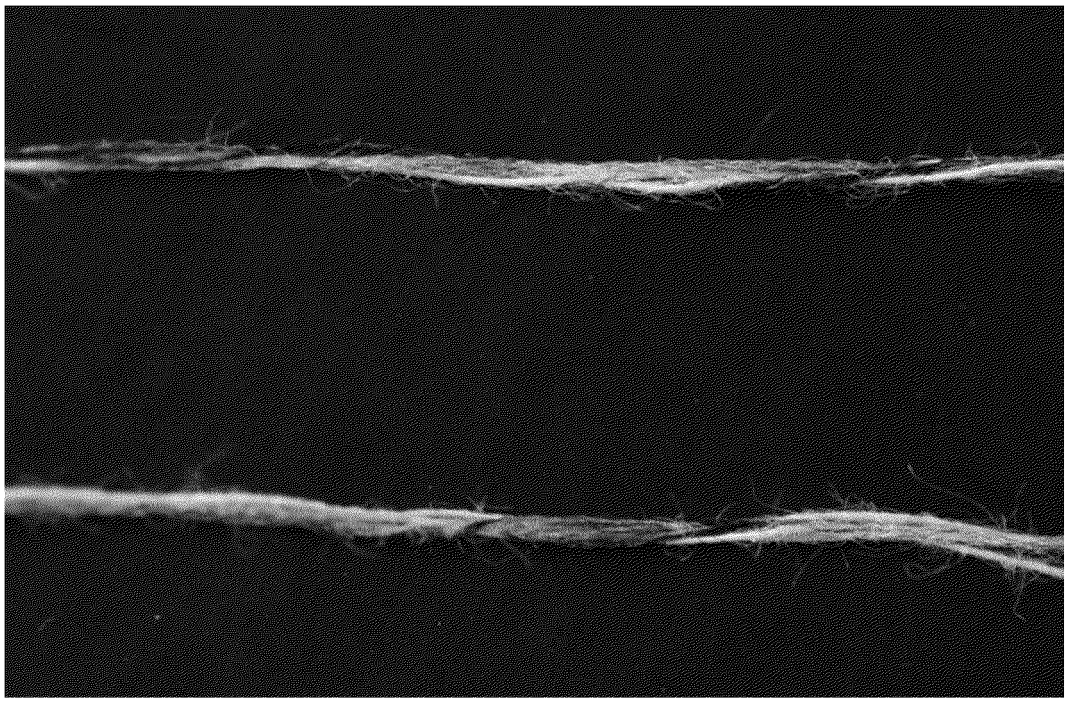


FIGURE 14

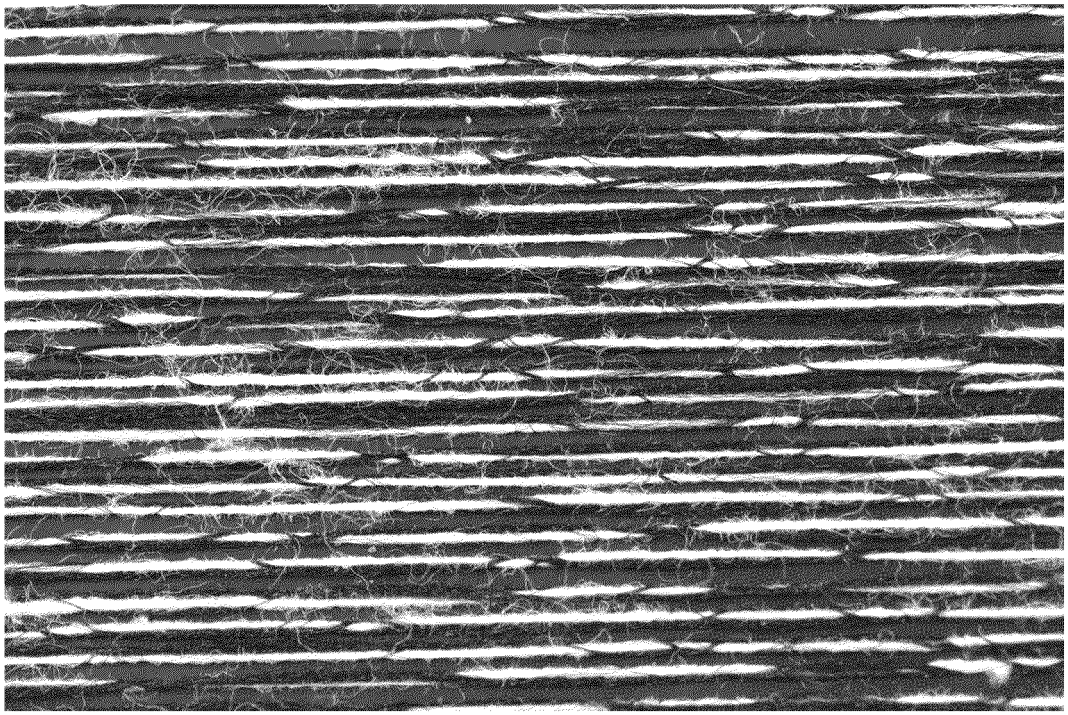


FIGURE 15

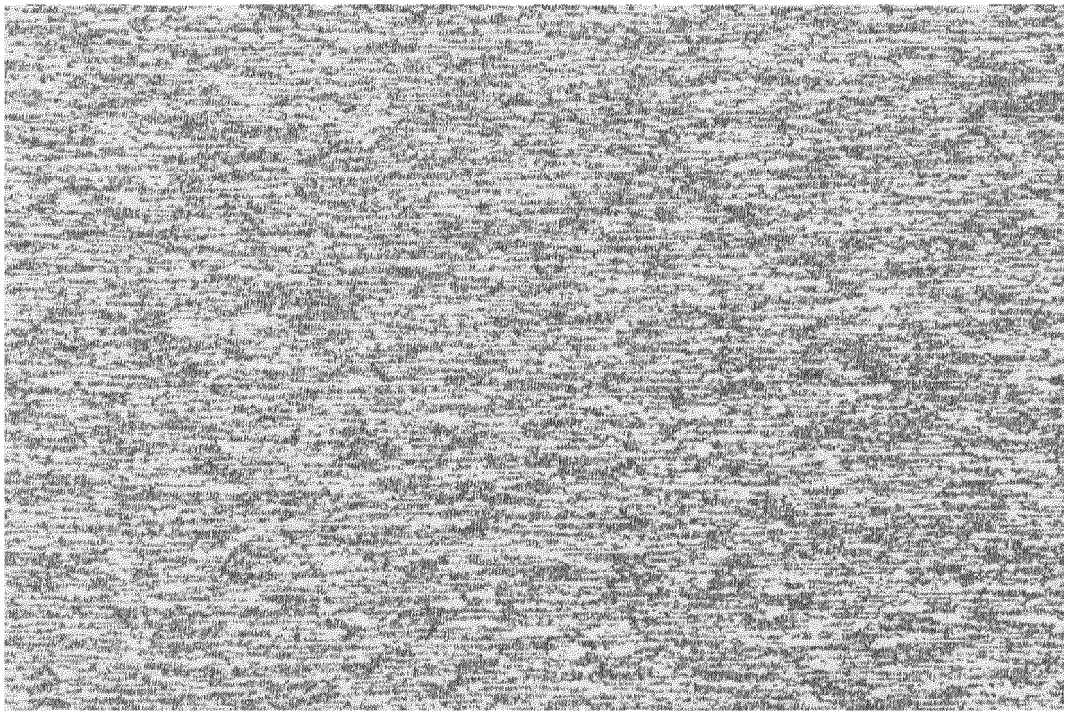


FIGURE 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BR2022/050215

A. CLASSIFICATION OF SUBJECT MATTER

IPC D02G1/16 (2006.01), D02G3/04 (2006.01), D02J1/08 (2006.01)
CPC D02G1/16, D02G3/04, D02J1/08

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)

IPC/CPC D02G, D02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Base de patentes do INPI-BR

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

ESPACENET, DERWENT INNOVATION

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	**BR PI0704157 A (FIOS TEXTEIS H MARIN LTD A [BR]) 16 September 2008 (2008-09-16) (the whole document)**	1-11, 16-18
A		12-15
X	**BR 102018075494 A2 (ANTONIO HERMINIO MARIN [BR]) 16 June 2020 (2020-06-16) (the whole document)**	1-11, 16-18
A		12-15
X	**BR 102019012508 A2 (ANTONIO HERMINIO MARIN [BR]) 29 December 2020 (2020-12-29)**	1-18
A	**BR PI0701681 A2 (FIOS TEXTEIS H MARIN LTD A [BR]) 23 December 2008 (2008-12-23) (the whole document)**	1-18

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09/09/2022	**15/09/2022**
Name and mailing address of the **ISA/ BR**	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BR2022/050215

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 108774770 B (UNIV SUZHOU) 14 Mai 2021 (2021-05-14)	1-18
A	CN 108486714 A (UNIV JIANGNAN) 04 September 2018 (2018-09-04)	1-18
A	CN 108486714 A (UNIV JIANGNAN) 04 September 2018 (2018-09-04)	1-18
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