



(51) International Patent Classification:

B65H 65/00 (2006.01)

(21) International Application Number:

PCT/IB2020/052399

(22) International Filing Date:

16 March 2020 (16.03.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/818,954

15 March 2019 (15.03.2019)

US

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(81) Designated States (unless otherwise indicated, for every

kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every

kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: PACKAGE TIE-OFF SYSTEM

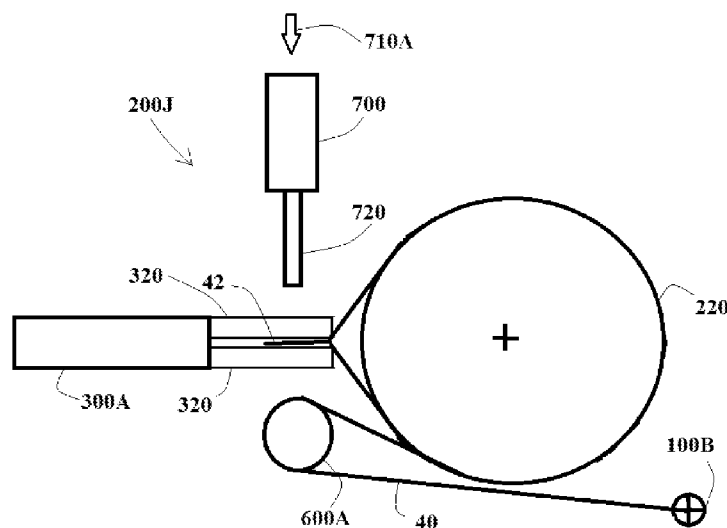


FIG. 2J

(57) Abstract: A system includes a bobbin (220), a source of moving air (140), a finger (600A), a first filament retainer (300A), and an insertion filament retainer (700). The spindle-mounted bobbin (220) has a supply of wound filament terminating in a first end proximate an outer surface. The bobbin (220) is configured for controlled rotation about a longitudinal axis (210). The source of moving air (140) is aligned axially relative to an orifice of a fairlead (100B) positioned to engage the first end. The finger (600A) is pivotally mounted in a manner to remain aligned parallel to the longitudinal axis (210) and configured for axial displacement. The first filament retainer (300A) has an open center jaw (320) configured to engage a first segment of the filament (40) and rotate about a radial axis relative to the longitudinal axis (210). The insertion filament retainer (700) is configured to grasp a second segment of the yarn through a loop (42) formed in the first segment and configured to extract the second segment through the loop (42).

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
- *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

PACKAGE TIE-OFF SYSTEM

CLAIM OF PRIORITY

This patent application claims the benefit of priority of U.S. Provisional
5 Patent Application Serial Number 62/818,954, filed on March 15, 2019, which is
hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

This document pertains generally, but not by way of limitation, to
10 manufacturing using bobbin-wound filaments.

BACKGROUND

Equipment for processing bobbin-wound filaments, such as a yarn package,
present challenges in handling. Limited capacity of the bobbin requires that
15 depleted bobbins are periodically replaced with new inventory. A knot in the free
end of the filament can reduce waste and losses due to free end entanglement.
However, manual tie-off is labor intensive. Currently available systems for tying-
off the package can cause filament damage due to gripping and pinching and are
poorly-suited for integration into fixture-based automated handling equipment.
20 An example of a knot tying machine is mentioned in US 6,641,181.

SUMMARY

The inventor has recognized that a problem to be solved involves knot tying
without incurring crushing damage to filaments, maintaining suitable yarn tension
25 while tying, and controlling the position of a knot on the yarn.

The inventor has put forth a solution that implements a pneumatic yarn
capture and tensioner system with programmed manipulation of non-compressive
yarn guides and coordinated bobbin rotation to form a slip-knot.

Each of these non-limiting examples can stand on its own or can be combined in various permutations or combinations with one or more of the other examples.

5 This overview is intended to provide an overview of subject matter of the present patent application. It is not intended to provide an exclusive or exhaustive explanation of the invention. The detailed description is included to provide further information about the present patent application.

BRIEF DESCRIPTION OF THE DRAWINGS

10 In the drawings, which are not necessarily drawn to scale, like numerals may describe similar components in different views. Like numerals having different letter suffixes may represent different instances of similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

15 FIG. 1 illustrates an example of a fairlead, according to one embodiment.

FIGS. 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K, 2L, and 2M illustrate a sequence of events for operating selected elements of a system, according to one embodiment.

20 FIGS. 3A and 3B illustrate views of a filament retainer, according to one embodiment.

FIG. 4 illustrates an example of a pump jet, according to one embodiment.

FIG. 5 illustrates an example of a flow chart of a method, according to one embodiment.

FIG. 6 illustrates an example of a finger, according to one embodiment.

25 FIG. 7 illustrates a schematic view of a system, according to one embodiment.

DETAILED DESCRIPTION

FIG. 1 illustrates an example of fairlead 100A, according to one embodiment. Fairlead 100A, in the example shown, includes a body having orifice 120. Orifice 120, as shown, has chamfered corners. Corners can also be radiused and are configured to pass a running yarn without damage or excess resistance. Fairlead 100, in this example, includes a plurality of biased discharge ports 130. The discharge ports are coupled to source of air flow 140. Ports 130 are arranged to induce air flow in the direction of arrow 150. Fairlead 100A can be fabricated of metal or a polymer or other such material.

In operation, air flowing in the direction of arrow 150 is configured to draw in a free end of yarn when the yarn and orifice 120 are in close proximity. In some examples, the fairlead is described with the adjective pneumatic to indicate that air movement, by an air pump, a blower, compressed air, a vacuum, or other such equipment, provides the motive force to draw in and retain the free end of a yarn or a filament.

An example of the present subject matter utilizes a pneumatic fairlead, such as fairlead 100A.

FIGS. 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K, 2L, and 2M illustrate a sequence of events for forming a tie-off knot utilizing selected elements of a system as disclosed herein. Reference numerals appear in the various figures. In the figures, a filament is wound on a bobbin having longitudinal axis denoted here as axis 210. The views illustrated depict an end of a bobbin. In addition, the scenes illustrate a pneumatic fairlead engaging a free end of the bobbin-wound filament. As noted, a free end of filament 40 is routed through fairlead 100B. Fairlead 100B is indicated with a cross-hairs symbol to indicate that the direction of air movement is into the image.

In FIG. 2A, for example, scene 200A illustrates bobbin 220 having free end of filament 40 engaged with fairlead 100B. Finger 600A is depicted as cylindrical element corresponding to a shaft or a conical element. An axis of finger 600A is

aligned in parallel with longitudinal axis 210. In this scene, an outer surface of finger 600A is engaging filament 40. Finger 600A is carried in a fixture that allows movement about bobbin 220, and in this scene, finger 600A is travelling in a direction indicated by arrow 240.

5 In FIG. 2B, scene 200B illustrates finger 600A having arrived at a position above bobbin 220. The movement of finger 600A relative to bobbin 220 has separated a winding of filament 40.

In FIG. 2C, scene 200C illustrates finger 600A having arrived at a position alongside bobbin 220 by travelling in the direction of arrow 240A. The separated
10 winding of filament 40 is in position for capture by jaws 320 of first filament retainer 300A.

First filament retainer 300A is retained by a prismatic joint that allows linear motion as indicated by arrow 250A.

In FIG. 2D, scene 200D illustrates first filament retainer 300A having
15 engaged the separated winding of filament 40. Jaws 320 articulate between an open position (in which the filament is unretained) and a closed position (in which the filament is retained). First filament retainer 300A is configured to rotate about an axis as shown by arrow 260.

In FIG. 2E, scene 200E illustrates first filament retainer 300A having
20 rotated, as indicated by arrow 260, to a position in which the faces of jaws 320 are aligned parallel with the bobbin axis. The rotation of first filament retainer 300A has formed loop 42 in filament 40. In this scene, finger 600A has disengaged from filament 40 and is omitted from the scene. Disengagement of finger 600A, in one
25 example, includes translation along a path parallel with the bobbin axis. In this example, finger 600A is displaced in a direction that emerges from the image view. First filament retainer 300A is urged in a direction denoted by 250B to retain the loop 42.

In FIG. 2F, scene 200F depicts first filament retainer 300A retaining loop 42 in jaws 320. In addition, free end of filament 40 continues to be retained by the pneumatic fairlead.

5 Finger 600A has moved to a position about bobbin 220 and is travelling in the direction of arrow 240B.

In FIG. 2G, scene 200G illustrates continued travel (in the direction of arrow 240B) of finger 600A to a point where finger 600A engages with a portion of the filament 40 near pneumatic fairlead.

10 In FIG. 2H, scene 200H illustrates continued travel (in the direction of arrow 240B) of finger 600A to a point where finger 600A is positioned proximate loop 42. In this manner, filament length has been extracted from pneumatic fairlead.

In FIG. 2J, scene 200J illustrates insertion filament retainer 700 traveling in the direction of arrow 710A. Insertion filament retainer 700 includes narrow jaws 720 sized and configured to pass through loop 42 and pass through an open center
15 clearance region of jaw 320.

In FIG. 2K, scene 200k illustrates a time when narrow jaws 720 have penetrated the loop 42 and have captured a bight portion of filament 40. Finger 600A has been retracted and is omitted from the scene.

20 In FIG. 2L, scene 200L illustrates a time when narrow jaws 720 have withdrawn from 42 by movement of insertion filament retainer 700 in the direction indicated by arrow 710B. The bight portion of filament 40, has been carried through loop 42.

In FIG. 2M, scene 200M illustrates a time when narrow jaws 720 have released bight portion of filament 40 and are thus omitted from the scene. In
25 addition, loop 42 has contracted with rotational motion of bobbin 220 in the direction of arrow 270. Bobbin rotation has caused first loop 42 to cinch around the bight, and thus form a tie-off knot.

FIGS. 3A and 3B illustrate views of first filament retainer 300A, according to one embodiment. FIG. 3A depicts a side view illustrating the open center

configuration of jaws 320 relative to a segment of filament 40. Body 310 has a circular profile and is configured for rotation as discussed elsewhere in this document. FIG. 3B depicts an end view of first filament retainer 300A. This view illustrates the closing direction of movement of the faces of jaws 320 as denoted by arrows 315. Jaw travel in a direction opposed to arrows 315 will open or release filament 40. The round section of body 310 is illustrated in this view.

FIG. 4 illustrates an example of pump jet 400, according to one embodiment. Pump jet 400 can be configured as a pneumatic fairlead in the same manner as fairlead 100A or fairlead 100B. Pressurized air provided by air flow element 440 is ejected by nozzles in a ring-type manifold within the throat of jet 400. Body 410 is positioned near free end of bobbin-wound filament 40. A free end of a filament, along with air, is drawn through in the direction of arrow 450.

FIG. 5 illustrates an example of a flow chart of method 500, according to one embodiment.

At 510, method 500 includes capturing a filament in a fairlead. The filament can have a free end that emerges from a winding wrapped about a bobbin. The filament can be captured in an orifice of a fairlead. The orifice can include one or more nozzles to artificially induce air movement in a direction aligned parallel with an axis of the orifice.

At 520, method 500 includes manipulating a finger to engage a first segment of the filament between the orifice and the bobbin. The finger can be translated relative to the bobbin in a manner to form a separated winding of filament adjacent a surface of the bobbin.

At 530, method 500 includes grasping the separated winding of filament using a jaw having an open center. The jaw can be manipulated to hold the filament in a fixed position relative to the bobbin.

At 540, method 500 includes manipulating the finger to disengage the finger from the separated winding. This can include movement of the finger in a direction parallel to the bobbin axis.

At 550, method 500 includes rotating the retained portion of the filament in a manner to form a closed loop in the separated winding. The filament portion is carried in jaws of a filament retainer.

At 560, method 500 includes manipulating the finger to engage the filament to form a bight in a segment. Continued translational movement of the finger can carry the bight to a position proximate the first loop.

At 570, method 500 includes manipulating an insertion filament retainer to draw the bight to the first loop and with continued movement, extract the bight through the loop.

At 580, method 500 includes rotating the bobbin on the longitudinal axis to cinch the bight in the first loop, thus fixing the tie-off knot.

FIG. 6 illustrates an example of finger 600B, according to one embodiment. Finger 600B has a conical segment 610 affixed to a round shaft segment 630. In addition, finger 600B includes flange 620 configured to retain a filament during manipulation of the finger and the filament. Finger 600B can be carried in a fixture having bearings to allow movement in directions denoted by arrow 640.

The conical configuration illustrated causes the filament to ride in a position adjacent the flange. This configuration is suitable for use with a bobbin having filament wound in a helix of either direction.

FIG. 7 illustrates a schematic view of system 730. System 730 illustrates bobbin 220 carried on axis 750. Axis 750 can include a spindle carried by link 796 and supported on base 780. Fairlead 100C can be affixed to base 780 or can be affixed to external structure into which base 780 is received. Finger 600C is configured to rotate about axis 750 and in one example, is carried by link 790. Finger 600C is configured to travel about bobbin 220 on path 740 with motion in directions denoted by arrow 240C. First filament retainer 300B is carried by link 792 and is configured to engage a filament of bobbin 220. Similarly, insertion filament retainer 760 is carried by link 794 and is configured to engage a filament of bobbin 220.

In the example illustrated, link 796 is coupled at one end to base 780 and coupled at another end to a spindle at axis 750.

In the example illustrated, link 790 is coupled at one end to finger 600C and coupled at another end to a spindle at axis 750. In one example, link 790 is omitted
5 and finger 600C is maneuvered in a track corresponding to path 740.

In the example illustrated, link 792 is coupled at one end to a spindle at axis 750 and coupled at another end to first filament retainer 300B. In one example, link 792 is coupled at one end to base 780 or other structure.

In the example illustrated, link 794 is coupled at one end to link 792 and
10 coupled at another end to insertion filament retainer 760. In one example, link 794 is coupled at one end to base 780 or other structure.

Any or all of links 796, 790, 792, and 794 can be coupled to base 780, coupled to a pallet, or coupled to other structure.

A pallet assembly can include link 796 with a spindle at axis 750 and base
15 780. In one embodiment, fairlead 100C is coupled to the pallet. In one embodiment, fairlead 100C is independent of the pallet. The position of the fairlead can affect the placement of the knot or can be selected based on movement direction of the finger and the maneuvering of the retainers. In other examples, the fairlead position and alignment can be maneuvered in order to form a knot. One example of
20 the present subject matter includes first filament retainer 300B and insertion filament retainer 760 coupled to a pallet. In another example, first filament retainer 300B and insertion filament retainer 760 are affixed to external structure configured to receive a pallet as described herein.

25 Various Notes

An example of the present subject matter includes a pneumatic fairlead to retain a free end of the filament in forming a tie-off knot. A pneumatic fairlead, as described herein, does not crush or damage the fibers of a filament. In addition, the knot location can be adjusted by modulating tension using the bobbin rotary

position. In addition, the filament retention, and thus filament tension, can be controlled by modulating air movement in the fairlead. The fairlead retention forces are a function of the air volume and velocity (pressure gradient), the surface characteristics of the filament, the physical dimensions of the filament, the orifice
5 dimension, and other factors. In some example, a vacuum source is applied to draw the filament through the orifice.

In one example, the first filament retainer or the insertion filament retainer includes a hook or feature projection rather than movable jaws. The first filament retainer or the insertion filament retainer can include a grasper mechanism having
10 movable jaws. In one example, a retainer (such as the first filament retainer or the insertion filament retainer) includes a projection in a fixed position that is configured to encircle, trap, or constrain a filament. In one example, the retainer includes a split ring, a corkscrew, pigtail, or other element having a helix shape. In one example, the retainer includes a hook or a fork.

15 In one example, a device is configured to tie a releasable knot. The device includes a first fixture for repeatably locating a bobbin of filament or thread having a free end. The device includes a second fixture for repeatably locating the free end. The device includes a spindle or axle for winding and unwinding the bobbin. The device includes an end tensioner for maintaining tension on the free end of the
20 bobbin. The device includes a first looper for forming a first loop in the free end while the tensioner maintains tension on the free end. The device includes a second looper for forming a second loop in the free end and positioning the second loop through the first loop to make a releasable knot. Positioning the second loop can include pulling the second loop or pushing the second loop. The second fixture is
25 configured to hold the free end in fixed spatial relationship to the air jet. The end tensioner can include an air tensioner, a pinching jaw, at least one tensioning roller and a tensioning spindle. The second fixture can include a tube section. The first fixture can include a transport pallet. The bobbin and the tube section can both be attached to the transport pallet, and the attachment is sufficient to repeatably locate

the bobbin and the tube section in relation to each other. The first looper or the second looper can include a rotatable looper. The first looper or the second looper can include a gripper, a fork, a hook or a tube. The first looper or the second looper can include a vacuum.

5 In one example, the bobbin is carried in a fixture that is sometimes referred to as a pallet. The pallet provides support for a spindle of the bobbin and allows the bobbin to be carried about the production facility. The pallet can include a drive motor for rotating the bobbin or the pallet can include a coupling that receives rotary motion for rotating the bobbin. In one example, the pallet engages with a machine
10 that carries the finger and controls motion about the bobbin in the pallet. In one example, the filament retainers are carried by the machine. In various examples, the fairlead is affixed rigidly to the pallet or the fairlead is affixed to the machine which receives the pallet. The fairlead can have a flow axis aligned in parallel with the bobbin axis, aligned tangential to the bobbin axis, or aligned at any angle.

15 In one example, finger 600C is configured to travel about bobbin 220. The travel path can have a start point and a stop point at various locations about bobbin 220. For example, the illustrations of FIGS. 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K, 2L, and 2M illustrate an arrangement where the finger travel begins at approximately 4:30 o'clock position on the clock face (assuming noon is at top of
20 image in figure), travels counterclockwise, and terminates at approximately 9:00 o'clock position. With the finger at the 9:00 o'clock position, the insertion filament retainer 700 is maneuvered to engage with the filament carried by finger 600A and form a knot. In another example, the finger has a starting point at approximately 4:00 o'clock position and travels in a clockwise direction and angular movement
25 terminates at a position approximately at the 3:00 o'clock position. In this example, the insertion filament retainer (such as insertion filament retainer 760) is maneuvered to engage with the filament at approximately the 3:00 o'clock position. Other finger travel starting positions, stopping positions, and direction of travel are also contemplated.

The present subject matter can include apparatus to control operation of various components. For example, any or all of the bobbin, the finger, the fairlead, and the retainers can be manipulated using an actuator such as a hydraulic actuator or a pneumatic actuator or an electric motor. In addition, a computer, such as a
5 digital processor or an analog processor, can be configured to control an actuator. For example, a digital processor can be configured with instructions to manipulate the system components described herein in order to perform the knot tying operation.

The above description includes references to the accompanying drawings,
10 which form a part of the detailed description. The drawings show, by way of illustration, specific embodiments in which the invention can be practiced. These embodiments are also referred to herein as “examples.” Such examples can include elements in addition to those shown or described. However, the present inventor also contemplates examples in which only those elements shown or described are
15 provided. Moreover, the present inventor also contemplates examples using any combination or permutation of those elements shown or described (or one or more aspects thereof), either with respect to an example (or one or more aspects thereof), or with respect to other examples (or one or more aspects thereof) shown or described herein.

20 In the event of inconsistent usages between this document and any documents so incorporated by reference, the usage in this document controls.

In this document, the terms “a” or “an” are used, as is common in patent documents, to include one or more than one, independent of any other instances or usages of “at least one” or “one or more.” In this document, the term “or” is used to
25 refer to a nonexclusive or, such that “A or B” includes “A but not B,” “B but not A,” and “A and B,” unless otherwise indicated. In this document, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.” Also, in the following claims, the terms “including” and “comprising” are open-ended, that is, a system, device,

article, composition, formulation, or process that includes elements in addition to those listed after such a term in a claim are still deemed to fall within the scope of that claim. Moreover, in the following claims, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects.

Geometric terms, such as “parallel”, “perpendicular”, “round”, or “square”, are not intended to require absolute mathematical precision, unless the context indicates otherwise. Instead, such geometric terms allow for variations due to manufacturing or equivalent functions. For example, if an element is described as “round” or “generally round,” a component that is not precisely circular (e.g., one that is slightly oblong or is a many-sided polygon) is still encompassed by this description.

Method examples described herein can be machine or computer-implemented at least in part. Some examples can include a computer-readable medium or machine-readable medium encoded with instructions operable to configure an electronic device to perform methods as described in the above examples. An implementation of such methods can include code, such as microcode, assembly language code, a higher-level language code, or the like. Such code can include computer readable instructions for performing various methods.

The code may form portions of computer program products. Further, in an example, the code can be tangibly stored on one or more volatile, non-transitory, or non-volatile tangible computer-readable media, such as during execution or at other times. Examples of these tangible computer-readable media can include, but are not limited to, hard disks, removable magnetic disks, removable optical disks (e.g., compact disks and digital video disks), magnetic cassettes, memory cards or sticks, random access memories (RAMs), read only memories (ROMs), and the like.

The above description is intended to be illustrative, and not restrictive. For example, the above-described examples (or one or more aspects thereof) may be used in combination with each other. Other embodiments can be used, such as by

one of ordinary skill in the art upon reviewing the above description. The Abstract is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. Also, in the above Detailed

5 Description, various features may be grouped together to streamline the disclosure. This should not be interpreted as intending that an unclaimed disclosed feature is essential to any claim. Rather, inventive subject matter may lie in less than all features of a particular disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description as examples or embodiments,

10 with each claim standing on its own as a separate embodiment, and it is contemplated that such embodiments can be combined with each other in various combinations or permutations. The scope of the invention should be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

15

THE CLAIMED INVENTION IS:

1. A system comprising:
 - a spindle-mounted bobbin having a supply of wound filament terminating in a first end proximate an outer surface, the bobbin configured for controlled rotation
 - 5 about a longitudinal axis;
 - a source of moving air aligned axially relative to an orifice of a fairlead positioned to engage the first end;
 - a finger pivotally mounted in a manner to remain aligned parallel to the longitudinal axis and configured for axial displacement;
 - 10 a first filament retainer having an open center jaw configured to engage a first segment of the filament and rotate about a radial axis relative to the longitudinal axis; and
 - an insertion filament retainer configured to grasp a second segment of the yarn through a loop formed in the first segment and configured to extract the second
 - 15 segment through the loop.
2. The system of claim 1 wherein the source of moving air includes a vacuum port.
- 20 3. The system of claim 1 wherein the source of moving air includes a jet pump.
4. The system of claim 1 wherein the source of moving air includes a positive pressure pump.
- 25 5. The system of claim 1 wherein the fairlead is fixedly mounted relative to the bobbin.

6. The system of claim 1 wherein the fairlead axis is substantially parallel with the longitudinal axis.
7. The system of claim 1 wherein the finger is configured to rotate about the longitudinal axis.
8. The system of claim 1 wherein the finger has a conical profile.
9. The system of claim 1 wherein the first filament retainer is affixed by a cylindrical joint.
10. The system of claim 1 wherein the insertion filament retainer is affixed by a prismatic joint.
11. The system of claim 1 wherein the bobbin is configured for motor-controlled rotation about the longitudinal axis.
12. A method comprising:
capturing a first end of a bobbin-wound filament in an orifice of a fairlead, the orifice having artificially induced air movement aligned parallel with an axis of the orifice;
manipulating a finger to engage a first segment of the filament between the orifice and the bobbin and repositioning the finger to form a separated winding of filament adjacent a surface of the bobbin;
grasping the separated winding of filament with a jaw having an open center;
manipulating the finger to disengage from the separated winding;
rotating the jaw to form a first loop in the filament;
manipulating the finger to engage the filament between the orifice and the bobbin and repositioning the finger to carry a bight segment of the filament to a position proximate the first loop;

manipulating a filament retainer to penetrate the first loop, engage the bight, and extract the bight through the first loop; and

rotating the bobbin on the longitudinal axis to cinch the bight in the first loop.

5

13. The method of claim 12 wherein capturing the first end of the bobbin-wound filament includes drawing a vacuum.

14. The method of claim 12 wherein repositioning the finger includes rotating the finger about the longitudinal axis in a first direction.

10

15. The method of claim 12 wherein manipulating the finger to disengage includes translating the finger along a finger axis aligned parallel to the longitudinal axis.

15

16. The method of claim 12 wherein rotating the jaw to form the first loop includes rotation through approximately 450 degrees.

17. The method of claim 12 wherein repositioning the finger to carry a bight segment of the filament includes rotating the finger about the longitudinal axis in a second direction, the second direction opposite the first direction.

20

18. The method of claim 12 wherein manipulating the filament retainer to penetrate the first loop includes moving in prismatic joint.

25

19. The method of claim 12 wherein engaging the bight includes at least one of hooking the bight or capturing the bight in a non-compressive jaw.

20. The method of claim 12 wherein rotating the bobbin on the longitudinal axis includes operating a motor drive.

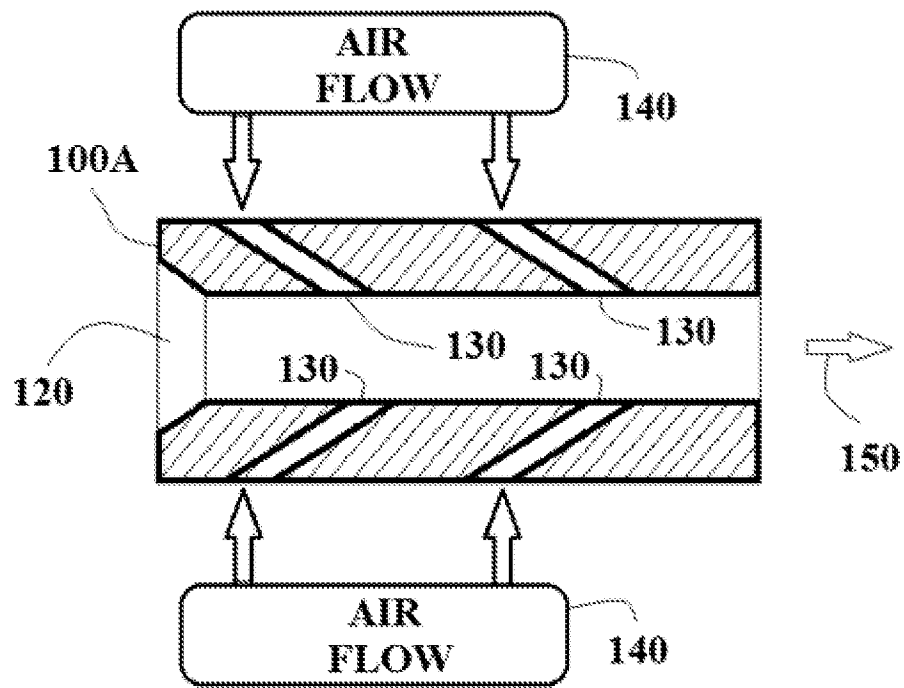


FIG. 1

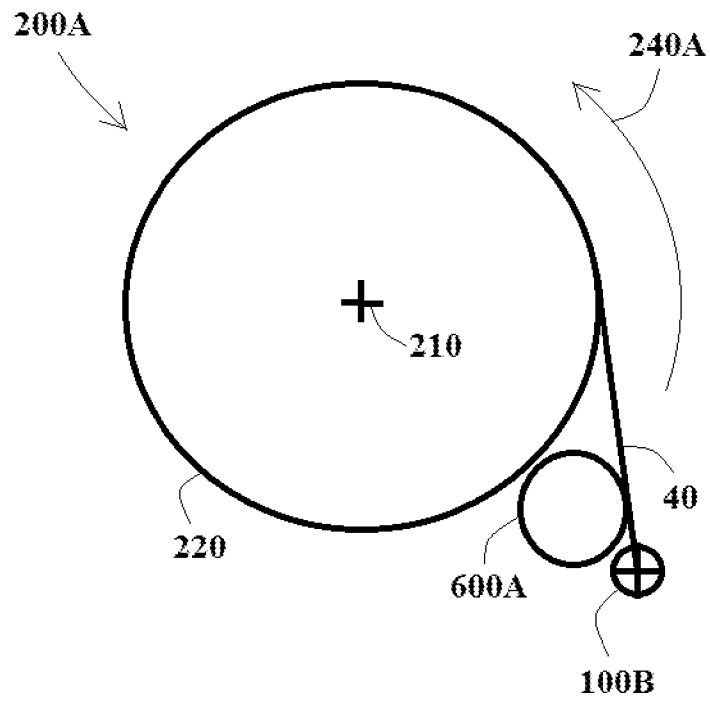


FIG. 2A

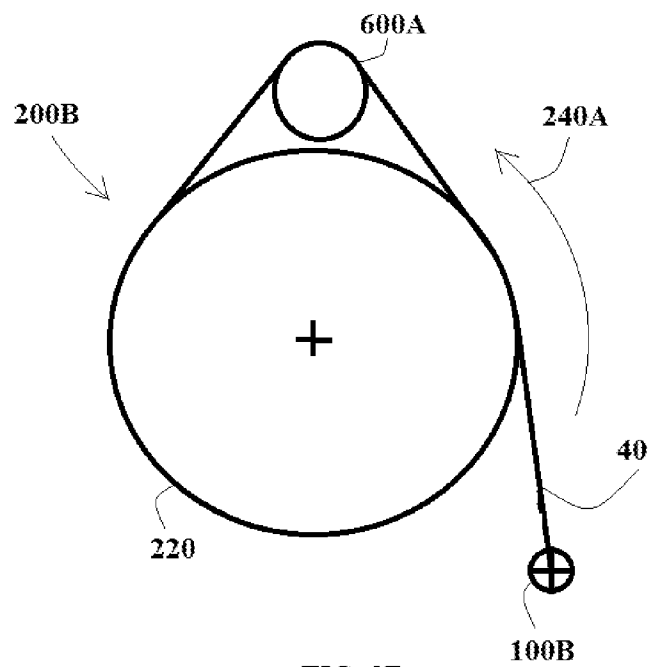
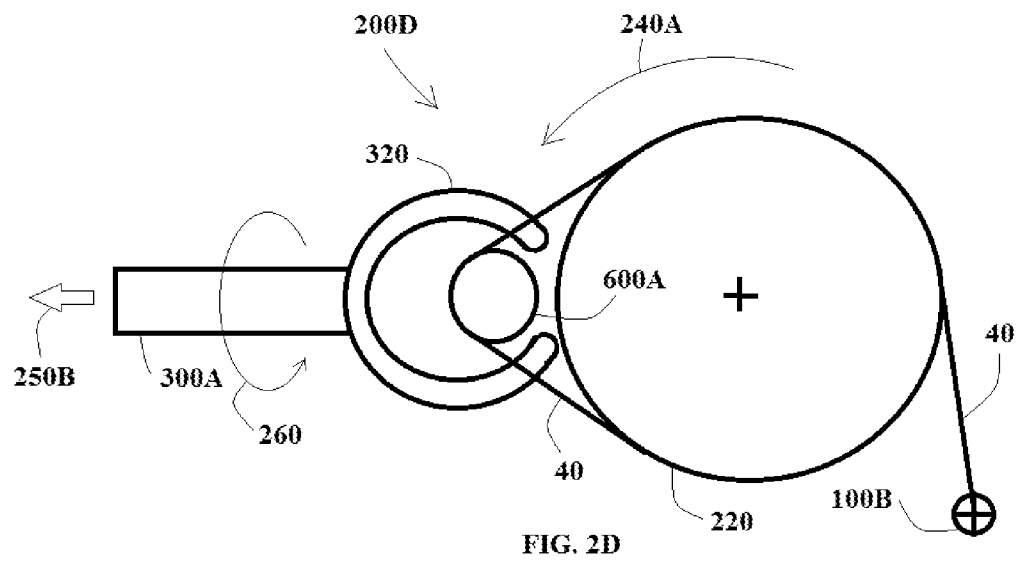
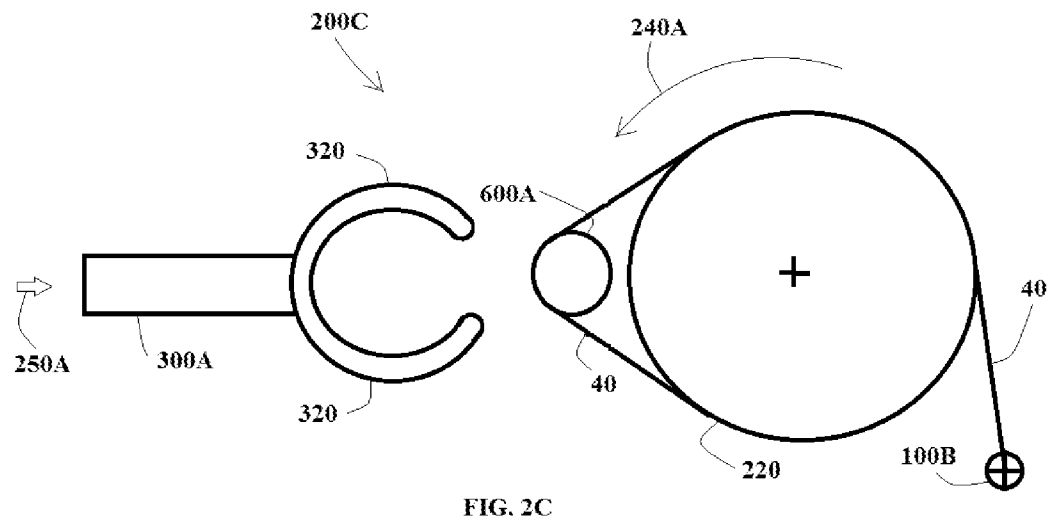
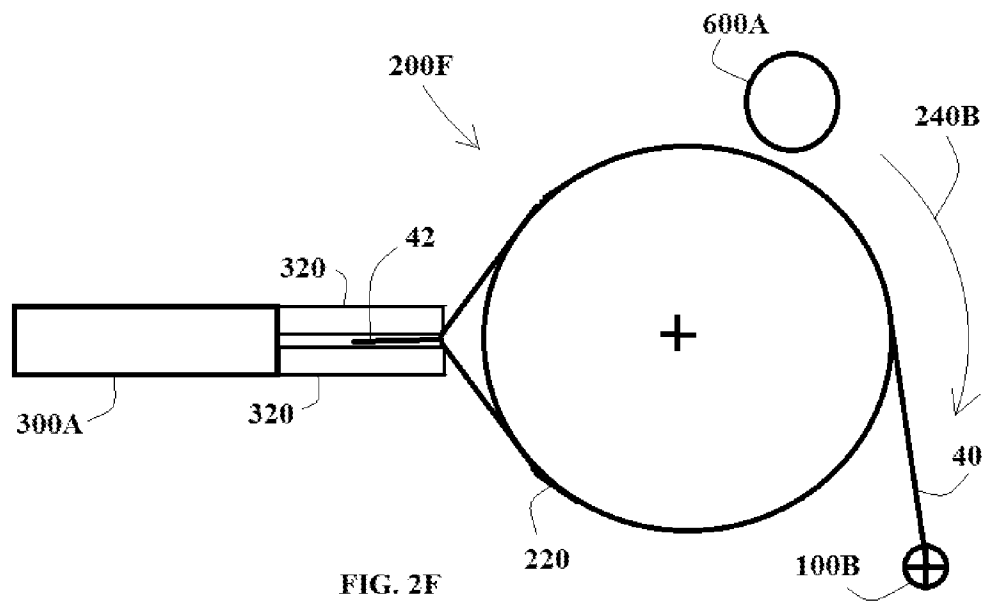
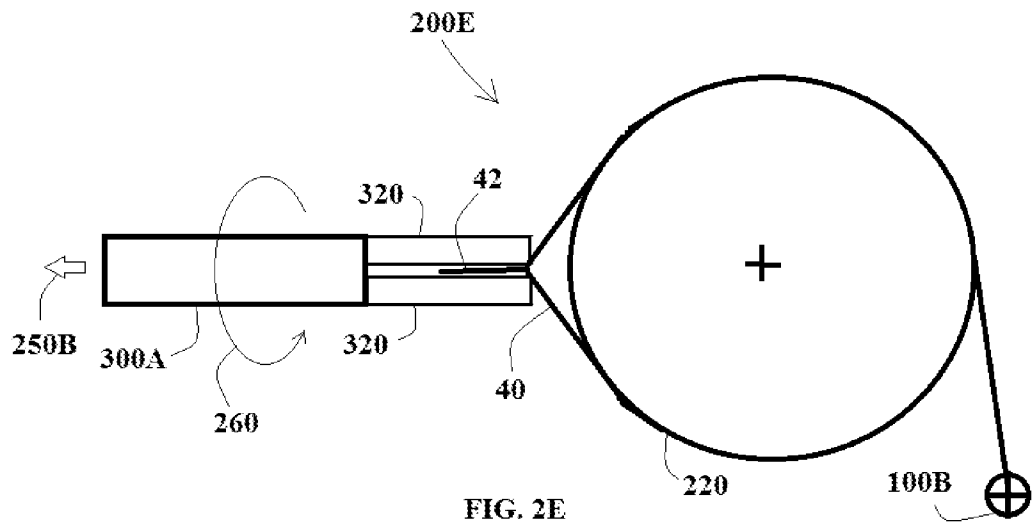
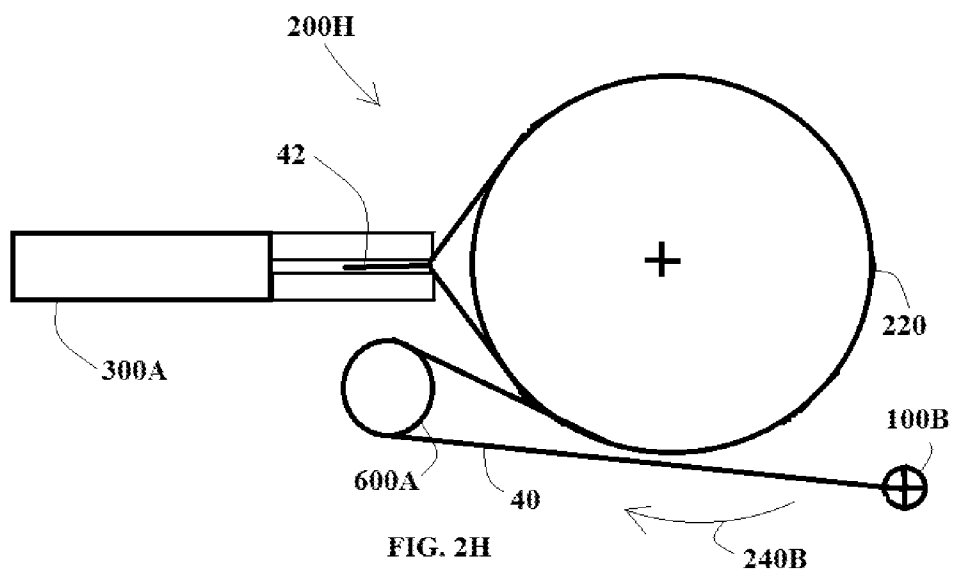
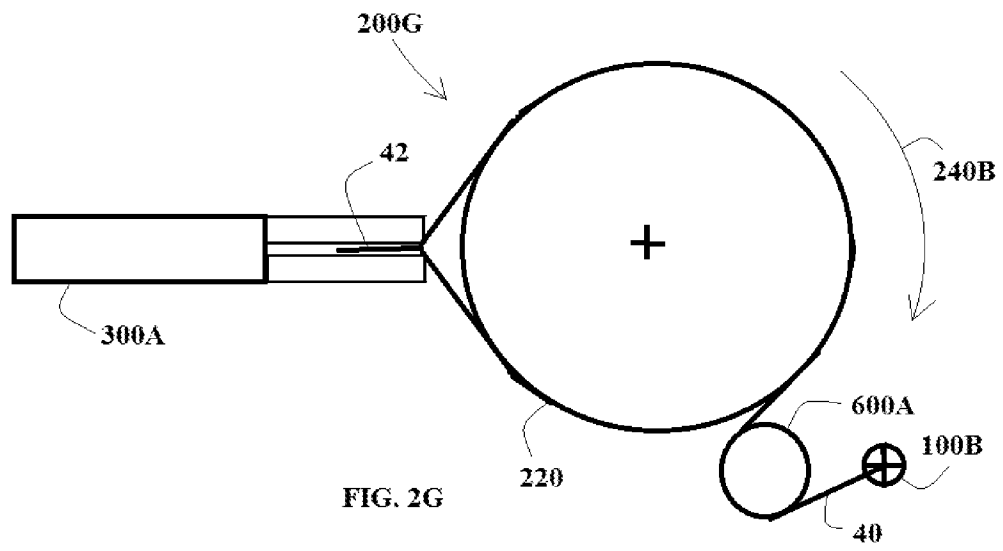


FIG. 2B







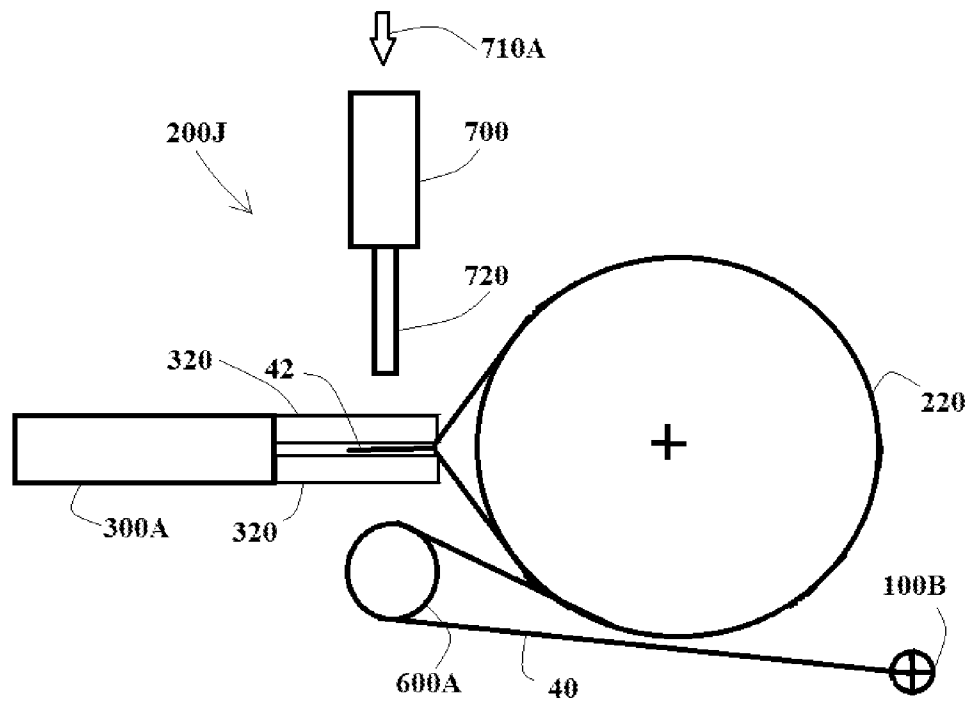


FIG. 2J

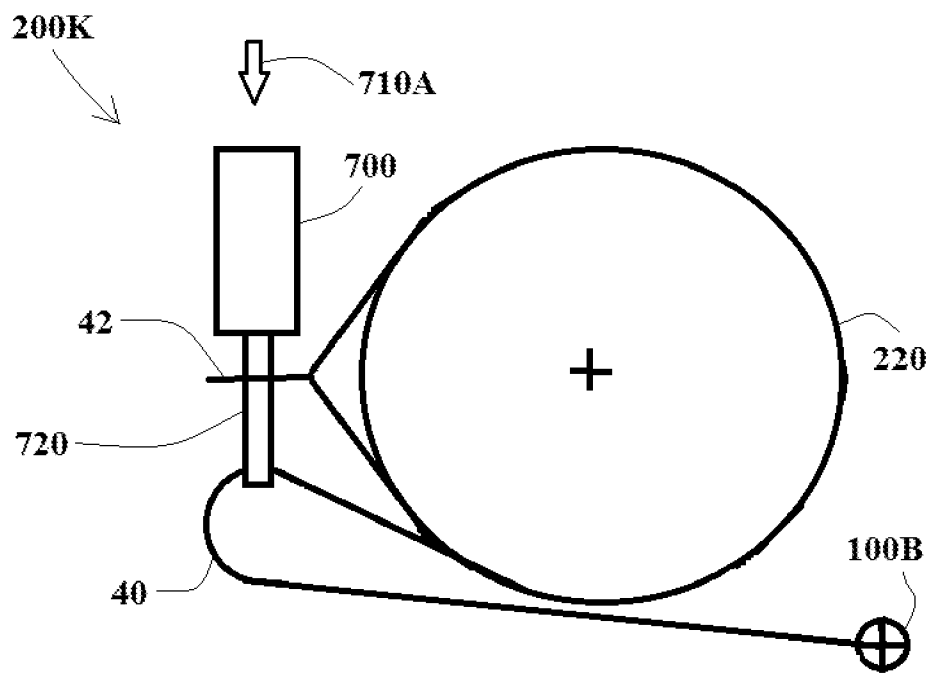
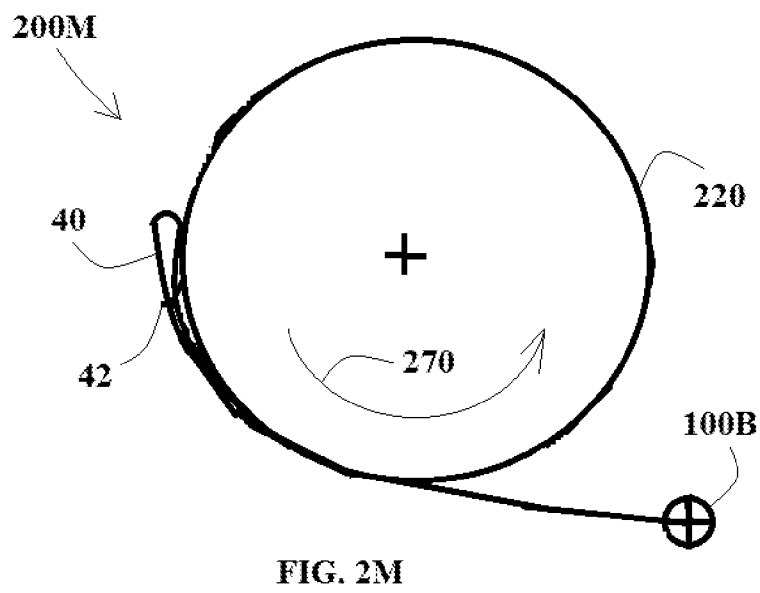
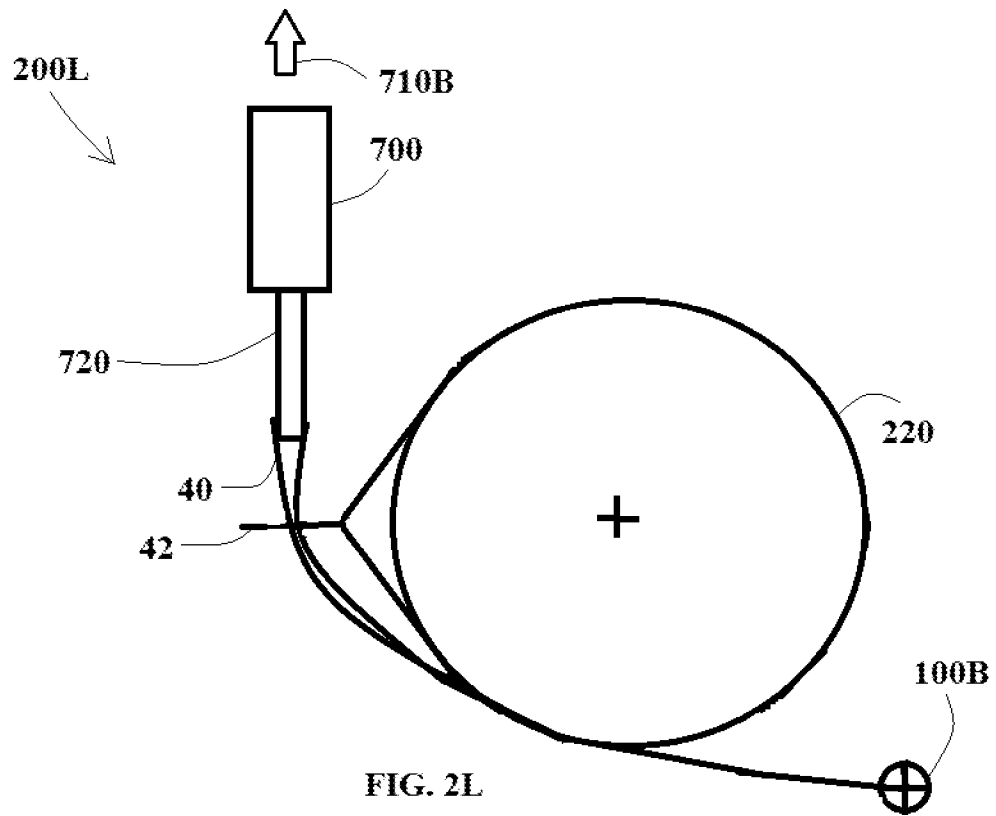
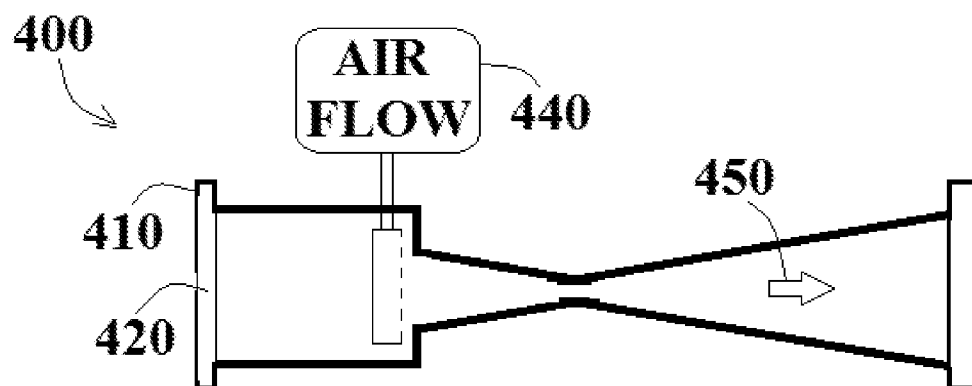
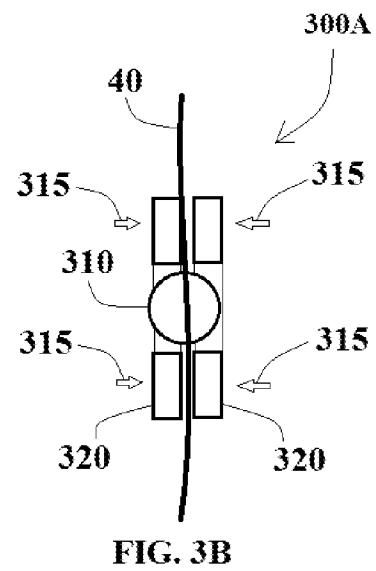
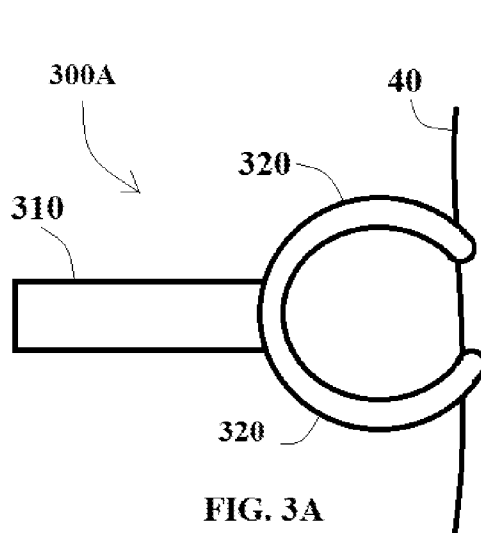


FIG. 2K





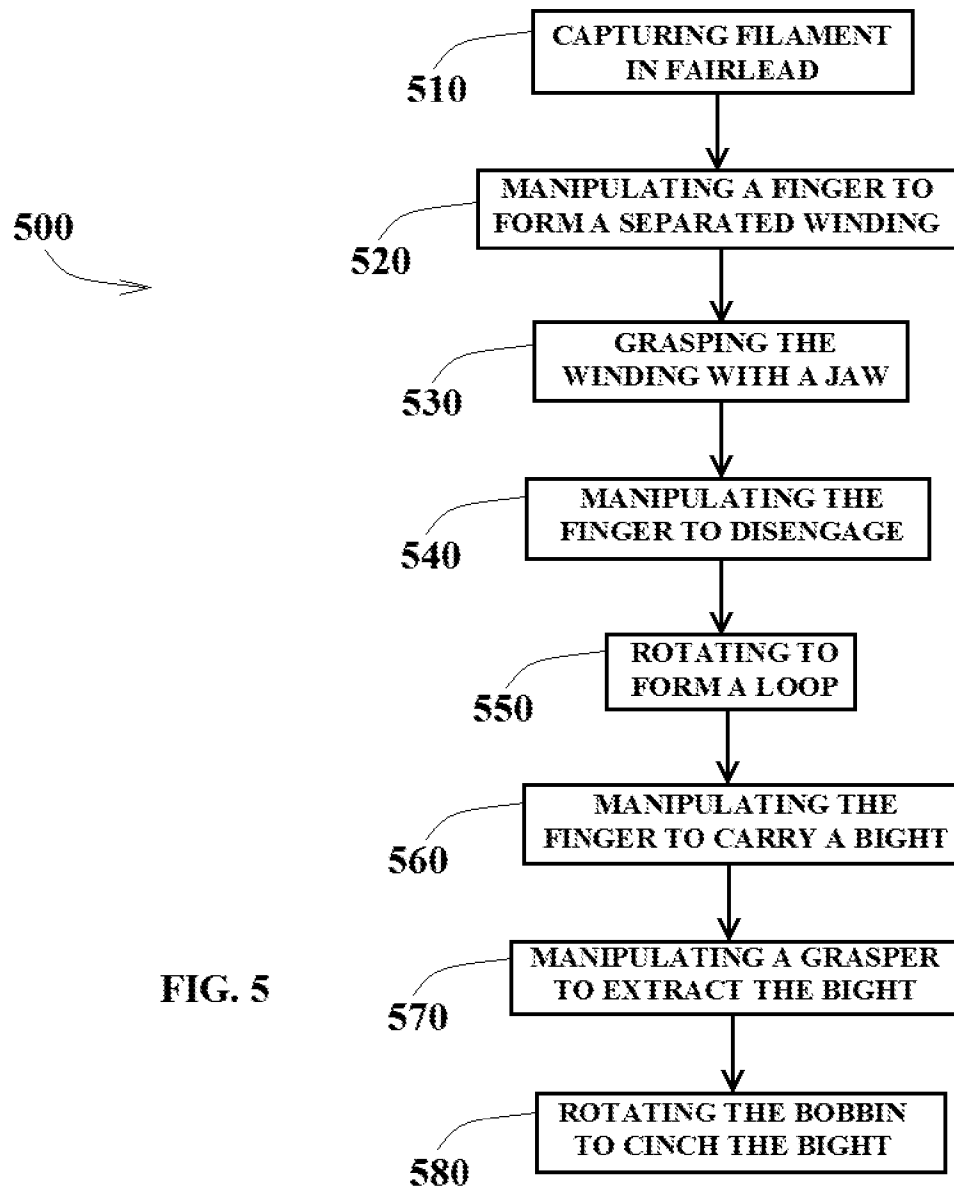


FIG. 5

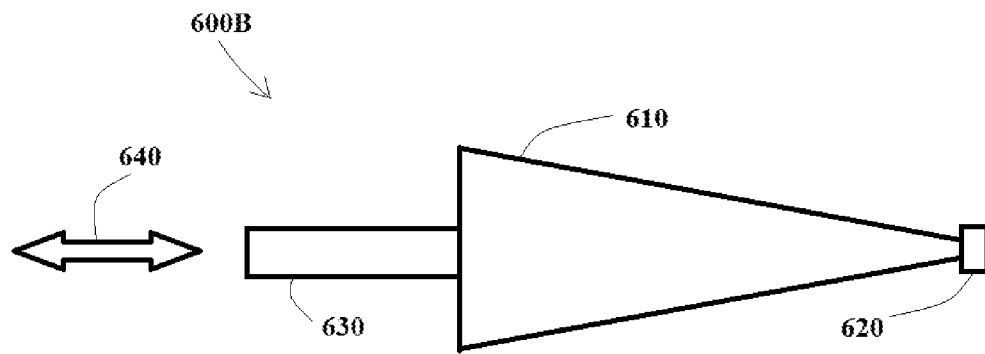


FIG. 6

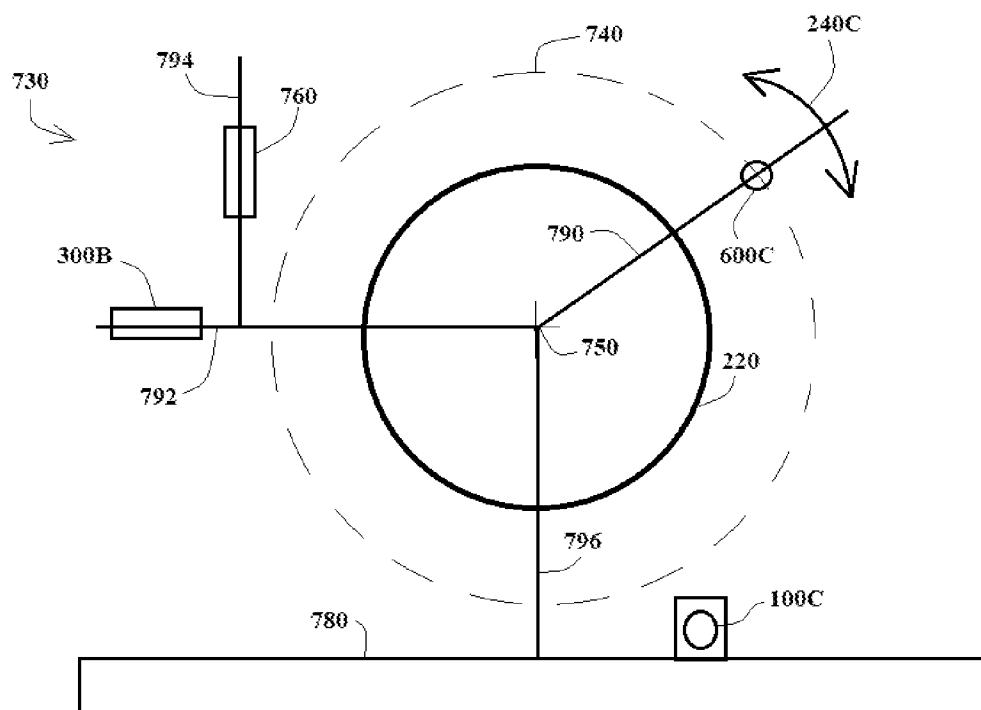


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2020/052399

A. CLASSIFICATION OF SUBJECT MATTER INV. B65H65/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) B65H		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 641 181 B2 (BELMONT TEXTIL MACH INC [US]) 4 November 2003 (2003-11-04) cited in the application column 5, line 44 - column 6, line 25; figures	1-20
A	----- US 5 425 509 A (VAN SEVEREN BERNARD [BE] ET AL) 20 June 1995 (1995-06-20) column 6, lines 3-58; figures	1-20
A	----- JP H07 133516 A (MURATA MACHINERY LTD) 23 May 1995 (1995-05-23) abstract; figures	1-20
A	----- DE 192 562 C (C.A. WALDENFELS) 10 December 1907 (1907-12-10) the whole document ----- -/--	1-20
☒ Further documents are listed in the continuation of Box C. ☒ 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	
15 June 2020	10/07/2020	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Lemmen, René	

INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP H07 291533 A (TORAY INDUSTRIES) 7 November 1995 (1995-11-07) abstract; figures -----	1-20
A	JP H08 319062 A (MURATA MACHINERY LTD) 3 December 1996 (1996-12-03) abstract; figures -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2020/052399

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6641181	B2	04-11-2003	US 2002060455 A1	23-05-2002
			US 2002171245 A1	21-11-2002

US 5425509	A	20-06-1995	AT 164565 T	15-04-1998
			BR 9302791 A	16-02-1994
			CN 1085871 A	27-04-1994
			DE 69317705 T2	13-08-1998
			JP H06191729 A	12-07-1994
			KR 940001956 A	16-02-1994
			US 5425509 A	20-06-1995

JP H07133516	A	23-05-1995	NONE	

DE 192562	C	10-12-1907	NONE	

JP H07291533	A	07-11-1995	JP 3413946 B2	09-06-2003
			JP H07291533 A	07-11-1995

JP H08319062	A	03-12-1996	NONE	
