(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 January 2020 (30.01.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/021325 A1

(51) International Patent Classification:
B65B 29/04 (2006.01)

(21) International Application Number:
PCT/IB2019/000255

(22) International Filing Date:
03 April 2019 (03.04.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10201806356R 25 July 2018 (25.07.2018) SG
10201810843X 03 December 2018 (03.12.2018) SG

(72) Inventor; and
(71) Applicant: **PRESSANNA, Rohan, De Lanerolle** [LK/LK]; 203, Horana Road, Wekada, Panadural (LK).

(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, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, 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:** A THREAD TYING MODULE FOR A TEABAG BAGGING MACHINE AND A METHOD OF ATTACHING A THREAD TO A TEABAG

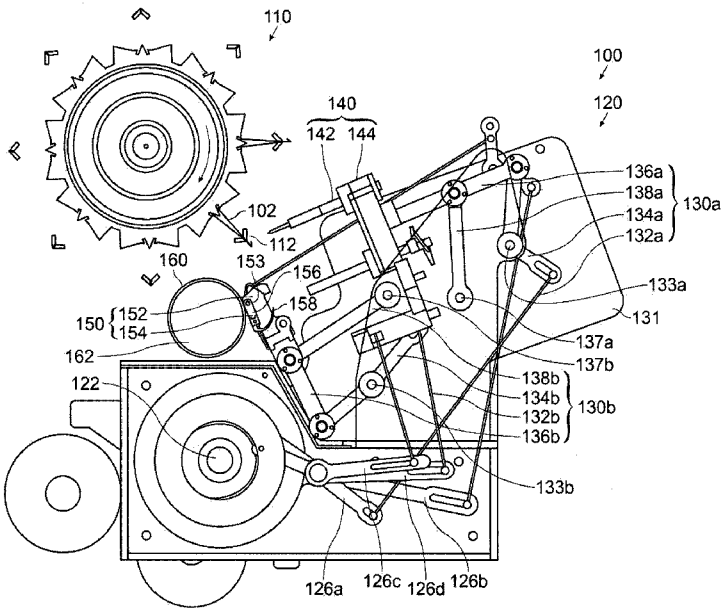

FIG. 1

(57) **Abstract:** A thread tying module may include a rotation shaft; two or more cams on the rotation shaft; two or more levers, each in engagement with a corresponding cam; two or more linkage mechanisms, each connected to a corresponding lever; a needle assembly including a needle configured to be rotatable about its longitudinal axis, and a needle holder connected to a first linkage mechanism configured to move the needle assembly to a forward disposition; and a thread pusher assembly including a thread pusher head connected to a second linkage mechanism configured to move the thread pusher assembly to a forward disposition and a thread inserter pivotably mounted to the thread pusher head, wherein, when both the assemblies are in the respective forward disposition, the thread pusher head engages and pushes a thread towards the needle assembly, and the needle assembly engages with the thread on the thread pusher head.

WO 2020/021325 A1

[Continued on next page]

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))*

A THREAD TYING MODULE FOR A TEABAG BAGGING MACHINE AND A METHOD OF ATTACHING A THREAD TO A TEABAG

Cross-reference to Related Applications

[0001] The present application claims the benefit of the Singapore patent application No. 10201806356R filed on 25 July 2018 and Singapore patent application No. 10201810843X filed on 3 December 2018, the entire contents of which are incorporated herein by reference for all purposes.

Technical Field

[0002] Various embodiments generally relate to a thread tying module for a teabag bagging machine, a system for attaching a thread to a teabag, and a method of attaching a thread to a teabag.

Background

[0003] Most conventional teabag bagging machines (for example 'Constanta' teabag bagging machine) adopt stapling to secure a tag to a teabag. This is because stapling has been the fastest and most effective way of securing the tag to the teabag. However, staples which are made of metal may contaminate the infusion of a teabag creating a disagreeable taste and may even lead to health problems. Thus, consumers are turning away from such teabags. This lead to the teabag manufacturers having to abandon such conventional teabag bagging machines so as to switch to new teabag bagging machines that does not use staple. The switching to new teabag bagging machines can be a very costly investment for the teabag manufacturers in view that the profit from manufacturing each teabag is extremely low, and it may be wasteful to abandon the existing teabag bagging machines.

[0004] Accordingly, there is a need for a cheaper and less wasteful solution for the teabag manufacturers to produce teabag without using staples.

Summary

[0005] According to various embodiments, there is provided a thread tying module configured to be mounted to a teabag bagging machine. The module may include a rotation

shaft configured to be coupled to a driving mechanism. The module may further include two or more cams fixedly joined to the rotation shaft such that the two or more cams rotate together with the rotation shaft. The module may further include two or more levers, each lever having a first connection portion in engagement with a corresponding cam of said cams, and having a pivot axis parallel to a rotational axis of the rotation shaft. The module may further include two or more linkage mechanisms, each linkage mechanism connected to a respective second connection portion of a corresponding lever of said levers. The module may further include a needle assembly including a needle and a needle holder, the needle configured to be rotatable about its longitudinal axis with respect to the needle holder, the needle holder being connected to a first linkage mechanism of the linkage mechanisms, configured to impart a translation motion to the needle assembly in a plane perpendicular to the rotational axis of the rotation shaft so as to move the needle assembly between a forward disposition, an intermediate disposition and a retracted disposition. The module may further include a thread pusher assembly including a thread pusher head and a thread inserter which is formed as an angular piece having a first inserter arm which is pivotably mounted to the thread pusher head with a pivot axis parallel to the rotational axis of the rotation shaft, and having a second inserter arm which is arc-shaped and extends in an angle relative to the first inserter arm, wherein the thread pusher head is connected to a second linkage mechanism of the linkage mechanisms, configured to impart a translation motion to the thread pusher assembly in the plane perpendicular to the rotational axis of the rotation shaft so as to move the thread pusher assembly between a forward disposition and a retracted disposition. According to various embodiments, the needle assembly and the thread pusher assembly may be arranged in a manner such that, when both the assemblies are in the respective forward disposition, the thread pusher head of the thread pusher assembly engages and pushes a thread towards the needle assembly, and the needle assembly engages with the thread on the thread pusher head of the thread pusher assembly.

[0006] According to various embodiments, there is provided a system for attaching a piece of thread to a teabag. The system may include the thread tying module as described herein and a teabag conveying module configured to convey the teabag to a knotting position with respect to the thread tying module so as to attach the piece of thread to the teabag. According to various embodiments, the teabag conveying module may include at least one teabag receiving portion having a hook. According to various embodiments, when said teabag receiving portion of the teabag conveying module is in the knotting position and the thread pusher assembly of the thread tying module is in the forward disposition, the hook of the teabag receiving portion may

be disposed with respect to the second inserter arm of the thread inserter of the thread pusher assembly in a manner such that a direction of movement of the second inserter arm of the thread inserter is toward the hook.

[0007] According to various embodiments, there is provided a method of attaching a piece of thread to a teabag held by a pair of teabag grippers. The method may include hooking, via a notch in a needle inserted through the teabag, a first mid-segment of a continuous portion of a thread adjacent to a first side of the teabag. The method may further include running said needle through the teabag along with the first mid-segment of the thread to a second side of the teabag opposite the first side and rotating the needle about its longitudinal axis to make an eye extending from the second side with the first mid-segment of the thread. The method may further include pushing, via a thread inserter, a second mid-segment of the continuous portion of the thread over an edge of the teabag from the first side to the second side, and inserting a loop of the second mid-segment through the eye formed by the first mid-segment to hang the loop of the second mid-segment on a hook of the teabag gripper at the second side of the teabag. The method may further include releasing the eye formed by the first mid-segment from the notch of the needle. The method may further include pulling, via a thread puller, a forward segment of the continuous portion of the thread before the first mid-segment so as to tighten the eye formed by the first mid-segment. The method may further include cutting the thread along an aft segment of the continuous portion of the thread after the second mid-segment. The method may further include removing the teabag from the pair of teabag grippers in a manner so as to pull the second mid-segment through the hook of the teabag gripper such that a cut-end of the thread may be correspondingly pulled through the eye formed by the first mid-segment before being pulled through the hook of the teabag gripper.

Brief description of the drawings

[0008] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments are described with reference to the following drawings, in which:

FIG. 1 shows a schematic diagram of a system for attaching a piece of thread to a teabag according to various embodiments;

FIG. 2 shows a perspective view of the system of FIG. 1 according to various embodiments;

FIG. 3A to FIG. 3E shows a series of movements of the respective components of the thread tying module of FIG. 1 and FIG. 2 in one revolution of the rotation shaft according to various embodiments;

FIG. 4A to FIG. 4L shows schematic diagrams of a method of attaching a piece of thread to a teabag according to various embodiments;

FIG. 5A shows a schematic diagram of a system for attaching a tag to a piece of thread 504 from a teabag according to various embodiments;

FIG. 5B shows a close up view of a tagging position of the system of FIG. 5A according to various embodiments;

FIG. 6A to FIG. 6G shows schematic diagrams of a method of attaching a tag to a piece of thread of a teabag according to various embodiments;

FIG. 7 shows a schematic diagram of a system for attaching a tag to a piece of thread from a teabag according to various embodiments; and

FIG. 8A to FIG. 8E shows schematic diagrams of a method of attaching the tag to the piece of thread of the threaded-teabag according to various embodiments.

Detailed description

[0009] Embodiments described below in the context of the apparatus are analogously valid for the respective methods, and vice versa. Furthermore, it will be understood that the embodiments described below may be combined, for example, a part of one embodiment may be combined with a part of another embodiment.

[00010] It should be understood that the terms "on", "over", "top", "bottom", "down", "side", "back", "left", "right", "front", "lateral", "side", "up", "down" etc., when used in the following description are used for convenience and to aid understanding of relative positions or directions, and not intended to limit the orientation of any device, or structure or any part of any device or structure. In addition, the singular terms "a", "an", and "the" include plural references unless context clearly indicates otherwise. Similarly, the word "or" is intended to include "and" unless the context clearly indicates otherwise.

[00011] Various embodiments relate to a thread tying module for a teabag bagging machine. According to various embodiments, the thread tying module may be configured to be installed

in a teabag bagging machine so as to attach a thread to a teabag (i.e. without using staples). According to various embodiments, the thread tying module may be configured to be installed on an existing conventional teabag bagging machine, which uses staples, so as to convert the existing teabag bagging machine into one which does not use staple. Accordingly, the thread tying module may be configured to be an attachment unit for direct installation on an existing conventional teabag bagging machine. According to various embodiments, the thread tying module may be configured to replace a staple module in the existing conventional teabag bagging machine. According to various embodiments, the thread tying module may also be configured to be installed in a new teabag bagging machine.

[00012] Various embodiments also relate to a system for attaching a thread to a teabag and a method of attaching a thread to a teabag. Various embodiments seek to provide a system and a method of attaching a continuous portion of a thread, stretching between a reservoir spool and a thread puller, to a teabag before cutting the thread to separate a segment of the thread attached to the teabag from the remaining thread extending from the reservoir spool. Accordingly, various embodiments may attach a thread to a teabag without using any ends of the thread for knotting. According to various embodiments, the system and method do not require a pre-cut length of thread for attaching a thread to a teabag. In the various embodiments, the thread may still be extending directly from the reservoir spool and an end of the thread may be held by the thread puller when the thread is being knotted to the teabag.

[00013] FIG. 1 shows a schematic diagram of a system 100 for attaching a piece of thread to a teabag 102 according to various embodiments. FIG. 2 shows a perspective view of the system 100 of FIG. 1 according to various embodiments. As shown, the system 100 may include teabag conveying module 110 and a thread tying module 120. According to various embodiments, the teabag conveying module 110 may be configured to convey the teabag 102 to a knotting position with respect to the thread tying module 120 so as to attach the piece of thread to the teabag 102. According to various embodiments, the teabag conveying module 110 may include at least one teabag receiving portion 112 configured to hold the teabag 102 that is to be conveyed by the teabag conveying module 110. According to various embodiments, the teabag conveying module 110 may include a plurality of teabag receiving portions 112. According to various embodiments, the teabag conveying module 110 may be mounted on a teabag bagging machine. According to various embodiments, the teabag conveying module 110 may be part of an existing teabag bagging machine.

[00014] According to various embodiments, the thread tying module 120 may be configured to be mounted to a teabag bagging machine. Accordingly, the thread tying module 120 may

be configured to be mounted to a frame or a support structure or a casing or a housing of the teabag bagging machine. According to various embodiments, various components of the thread tying module 120 may be directly mounted to the frame or the support structure or the casing or the housing of the teabag bagging machine. According to various embodiments, the thread tying module 120 may include a base frame 131 on which the various components of the thread tying module 120 may be fitted. Accordingly, the thread tying module 120 may be in the form of a single unit which may be mounted to the teabag bagging machine by mounting the base frame 131 to the teabag bagging machine. According to various embodiments, the thread tying module 120 may include a rotation shaft 122 configured to be coupled to a driving mechanism in a manner so as to be driven by the driving mechanism. According to various embodiments, the driving mechanism may be a driving shaft of the teabag bagging machine. According to various embodiments, the driving mechanism may be an external motor which is configured to synchronise with the movements of the teabag bagging machine. According to various embodiments, the rotation shaft 122 may be coupled to the driving mechanism via shaft couplings, or gears, or chains, or belts, or a combination thereof. According to various embodiments, the rotation shaft 122 may be rotatable with respect to the teabag bagging machine and/or the base frame 131.

[00015] According to various embodiments, the thread tying module 120 may include two or more cams 124a, 124b, 124c, 124d fixedly joined to the rotation shaft 122 such that the two or more cams 124a, 124b, 124c, 124d may rotate together with the rotation shaft 122. According to various embodiments the two or more cams 124a, 124b, 124c, 124d may be a disc cam, a plate cam, or a face cam. According to various embodiments, the disc cam or the plate cam may include an eccentric wheel. According to various embodiments, the face cam may include a disc with a slot or groove forming a closed curve on a face of the disc. According to various embodiments, the thread tying module 120 may include two or more levers 126a, 126b, 126c, 126d. According to various embodiments, each lever 126a, 126b, 126c, 126d may have a first connection portion (e.g. 128b, 128c) in engagement with a corresponding cam of said cams 124a, 124b, 124c, 124d. According to various embodiments, the first connection portion of respective lever 126a, 126b, 126c, 126d may include an end portion or an end of the respective lever 126a, 126b, 126c, 126d. According to various embodiments, each lever 126a, 126b, 126c, 126d may have a pivot axis 125 parallel to a rotational axis 121 of the rotation shaft 122. According to various embodiments, the two or more levers 126a, 126b, 126c, 126d may share the same pivot axis 125. According to various embodiments, the pivot axis 125 of the two or more levers 126a, 126b, 126c, 126d may be embodied in the form of a fixed axial

shaft 127 extending from a reference structure of the teabag bagging machine and/or the base frame 131 of the thread tying module 120 such that the two or more levers 126a, 126b, 126c, 126d may be pivotably mounted to the fixed axial shaft 127. According to various embodiments, a rotation of the rotation shaft 122 may rotate the respective cams 124a, 124b, 124c, 124d to generate a corresponding reciprocating (back and forth) motion in a corresponding lever 126a, 126b, 126c, 126d.

[00016] According to various embodiments, the thread tying module 120 may include two or more linkage mechanisms 130a, 130b, 130c, 130d. According to various embodiments, each linkage mechanism 130a, 130b, 130c, 130d may include an assembly of links arranged and connected in a manner to transfer movements and forces from a driving source so as to generate a desired motion. According to various embodiments, a connection (or a joint) between two links may be configured for rotation, or sliding, or both. According to various embodiments, each linkage mechanism 130a, 130b, 130c, 130d may be connected to a respective second connection portion 129a, 129b, 129c, 129d of a corresponding lever of said levers 126a, 126b, 126c, 126d. Accordingly, respective linkage mechanism 130a, 130b, 130c, 130d may generate a corresponding desired motion based on a movement of the corresponding lever of said levers 126a, 126b, 126c, 126d based on the rotation of the corresponding cam 124a, 124b, 124c, 124d.

[00017] According to various embodiments, the thread tying module 120 may include a needle assembly 140 including a needle 142 and a needle holder 144. According to various embodiments, the needle 142 may be configured to be rotatable about its longitudinal axis with respect to the needle holder 144. According to various embodiments, the needle 142 may be arranged to lie in a first plane (or a needle's plane) at least substantially perpendicular to the rotational axis 121 of the rotation shaft 122. According to various embodiments, the needle holder 144 may be connected to a first linkage mechanism 130a of the linkage mechanisms. The first linkage mechanism 130a may be configured to impart a translation motion to the needle assembly 140 in the first plane at least substantially perpendicular to the rotational axis 121 of the rotation shaft 122 so as to move the needle assembly 140 between a forward disposition, an intermediate disposition and a retracted disposition. Accordingly, the first linkage mechanism 130a may transfer a movement of a first lever 126a of said levers based on a rotation of the first cam 124a to generate a desired movement of the needle assembly 140. According to various embodiments, the desired movement of the needle assembly 140 may be between the forward disposition, the intermediate disposition and the retracted disposition.

[00018] According to various embodiments, the thread tying module 120 may include a thread pusher assembly 150 including a thread pusher head 152 and a thread inserter 154.

According to various embodiments, the thread inserter 154 may be formed as an angular piece having a first inserter arm 156 which is pivotably mounted to the thread pusher head 152 with a pivot axis 153 parallel to the rotational axis 121 of the rotation shaft 122, and having a second inserter arm 158 which is arc-shaped and extends in an angle relative to the first inserter arm 156. According to various embodiments, the thread inserter 154 may be arranged such that the first inserter arm 156 may lie in a second plane (or a first inserter arm's plane) at least substantially perpendicular to the rotational axis 121 of the rotation shaft 122. According to various embodiments, the second inserter arm 158 may extend from an end portion of the first inserter arm 156 and the pivot axis 153 of the thread inserter 154 may be located at an opposite end portion of the first inserter arm 156. According to various embodiments, the second plane may coincide with the first plane such that the second plane and the first place may be the same plane. Accordingly, the second inserter arm 158 may be oriented to lie in the same plane as the first inserter arm 156. According to various other embodiments, the second plane may be offset and parallel to the first plane such that the second inserter arm 158 may be oriented to incline from the second plane to the first plane.

[00019] According to various embodiments, the thread pusher head 152 may be connected to a second linkage mechanism 130b of the linkage mechanisms. The second linkage mechanism 130b may be configured to impart a translation motion to the thread pusher assembly 150 in the first plane at least substantially perpendicular to the rotational axis 121 of the rotation shaft 122 so as to move the thread pusher assembly 150 between a forward disposition and a retracted disposition. Accordingly, the second linkage mechanism 130b may transfer a movement of a second lever 126b of said levers based on a rotation of the second cam 124b to generate a desired movement of the thread pusher assembly 150. According to various embodiments, the desired movement of the thread pusher assembly 150 may be between the forward disposition and the retracted disposition.

[00020] According to various embodiments, the needle assembly 140 and the thread pusher assembly 150 may be arranged in a manner such that, when both the assemblies 140, 150 are in the respective forward disposition, the thread pusher head 152 of the thread pusher assembly 150 may engage and push a thread 104 (see FIG. 3A) towards the needle assembly 140, and the needle assembly 140 may engage with the thread 104 on the thread pusher head 152 of the thread pusher assembly 150. According to various embodiments, the needle 142 of the needle assembly 140, the thread pusher head 152 of the thread pusher assembly 150, and the thread 104 may be aligned so as to lie in the same first plane. According to various embodiments, the thread pusher head 152 of the thread pusher assembly 150 may include an engagement surface

intersecting the first plane. Further, the thread pusher head 152 of the thread pusher assembly 150 may include a groove on the engagement surface and extending along an intersection line between the engagement surface and the first plane in a manner such that the thread 104 may be received in the groove of the thread pusher head 152 of the thread pusher assembly 150. According to various embodiments, the thread pusher head 152 of the thread pusher assembly 150 may include a hole configured to receive the needle 142 of the needle assembly 140. Accordingly, the hole may be extending from the groove of the thread pusher head 152 and along the first plane in a direction away from the needle 142. Accordingly, when the needle 142 of the needle assembly 140 is inserted into the hole of the thread pusher head 152 of the thread pusher assembly 150, a notch on the needle 142 may engage with the thread 104 lying in the groove of the thread pusher head 152 of the thread pusher assembly 150.

[00021] According to various embodiments, the needle assembly 140 and the thread pusher assembly 150 may be arranged in a manner in which translation motions thereof are in directions in a range of 90° +/-10° relative to each other. Accordingly, the needle assembly 140 and the thread pusher assembly 150 may be oriented with respect to each other such that respective translation motions may be along intersecting paths angled at 90° +/-10° relative to each other. Hence, a direction of translation motion of the thread pusher head 152 of the thread pusher assembly 150 may intersect a direction of translation motion of the needle 142 of the needle assembly 140 at an angle in a range of 90° +/-10°.

[00022] According to various embodiments, the first linkage mechanism 130a may be a planar linkage mechanism. Accordingly, the relative motions of the links of the first linkage mechanism 130a may be in the same plane or in parallel planes. According to various embodiments, the first linkage mechanism 130a may include a first link rod 132a with a first connection portion connected to the second connection portion 129a of the first lever 126a. According to various embodiments, the first linkage mechanism 130a may further include a first rocker-arm-link 134a which has a pivot axis 133a parallel to the rotational axis 121 of the rotation shaft 122 and which has a first connection portion connected to a second connection portion of the first link rod 132a. According to various embodiments, the first linkage mechanism 130a may further include a first coupler link 136a with a first connection portion connected to a second connection portion of the first rocker-arm-link 134a. According to various embodiments, the first linkage mechanism 130a may further include a first follower link 138a which has a pivot axis 137a parallel to the rotational axis 121 of the rotation shaft 122 and which has a first connection portion connected to a second connection portion of the first coupler link 136a. According to various embodiments, the pivot axis 133a of the first

rocker-arm-link 134a and the pivot axis 137a of the first follower link 138a may be embodied in the form of fixed axial rods 135a, 139a extending from the reference structure of the teabag bagging machine and/or the base frame 131 of the thread tying module 120 such that the first rocker-arm-link 134a and the first follower link 138a may be pivotably mounted to respective fixed axial rods 135a, 139a. According to various embodiments, the needle holder 144 may be connected to the first coupler link 136a with the needle 142 arranged with its longitudinal axis extending parallel to a longitudinal extension of the first coupler link 136a. Accordingly, the needle holder 144 may align the needle 142 to the first coupler link 136a such that the longitudinal axis of the needle 142 may be parallel to the longitudinal extension of the first coupler link 136a.

[00023] According to various embodiments, the second linkage mechanism 130b may be a planar linkage mechanism. Accordingly, the relative motions of the links of the second linkage mechanism 130b may be in the same plane or in parallel planes. According to various embodiments, the second linkage mechanism 130b may include a second link rod 132b with a first connection portion connected to the second connection portion 129b of the second lever 126b. According to various embodiments, the second linkage mechanism 130b may further include a second rocker-arm-link 134b which has a pivot axis 133b parallel to the rotational axis 121 of the rotation shaft 122 and which has a first connection portion connected to a second connection portion of the second link rod 132b. According to various embodiments, the second linkage mechanism 130b may further include a second coupler link 136b with a first connection portion connected to a second connection portion of the second rocker-arm-link 134b. According to various embodiments, the second linkage mechanism 130b may further include a second follower link 138b which has a pivot axis 137b parallel to the rotational axis 121 of the rotation shaft 122 and which has a first connection portion connected to a second connection portion of the second coupler link 136b. According to various embodiments, the pivot axis 133b of the second rocker-arm-link 134b and the pivot axis 137b of the second follower link 138b may be embodied in the form of fixed axial rods 135b, 139b extending from the reference structure of the teabag bagging machine and/or the base frame 131 of the thread tying module 120 such that the second rocker-arm-link 134b and the second follower link 138b may be pivotably mounted to respective fixed axial rods 135b, 139b. According to various embodiments, the thread pusher head 152 may be connected to the second coupler link 136b. According to various embodiments, the thread pusher head 152 may be connected to the second connection portion of the second coupler link 136b. According to various embodiments, the second connection portion of the second coupler link 136b may be an end portion of the second

coupler link 136b such that the thread pusher head 152 may be extending from an end of a longitudinal extension of the second coupler link 136b.

[00024] According to various embodiments, the first coupler link 136a of the first linkage mechanism 130a and the second coupler link 136b of the second linkage mechanism 130b may longitudinally extend in directions in a range of 90° +/-10° relative to each other. Accordingly, the first coupler link 136a and the second coupler link 136b may be oriented with respect to each other such that respective longitudinal extensions may be angled at 90° +/-10° relative to each other. Hence, the first coupler link 136a and the second coupler link 136b may be oriented such that the respective longitudinal extensions may form an angle in a range of 90° +/-10° with respect to each other.

[00025] Referring to FIG. 1 and FIG. 2, according to various embodiments, the two or more cams may include four cams 124a, 124b, 124c, 124d, the two or more levers may include four levers 126a, 126b, 126c, 126d, and the two or more linkage mechanisms may include four linkage mechanisms 130a, 130b, 130c, 130d. According to various embodiments, each of the four cams 124a, 124b, 124c, 124d may be fixedly joined to the rotation shaft 122 such that each of the four cams 124a, 124b, 124c, 124d may rotate together with the rotation shaft 122. According to various embodiments, each of the four cams 124a, 124b, 124c, 124d may be a disc cam, a plate cam, or a face cam. According to various embodiments, the disc cam or the plate cam may include an eccentric wheel. According to various embodiments, the face cam may include a disc with a slot or groove forming a closed curve on a face of the disc.

[00026] According to various embodiments, each of the four lever 126a, 126b, 126c, 126d may have a first connection portion (e.g. 128b, 128c) in engagement with a corresponding cam of the four cams 124a, 124b, 124c, 124d. According to various embodiments, each of the four lever 126a, 126b, 126c, 126d may have a pivot axis 125 parallel to the rotational axis 121 of the rotation shaft 122. According to various embodiments, the four levers 126a, 126b, 126c, 126d may share the same pivot axis 125. According to various embodiments, the pivot axis 125 of the four levers 126a, 126b, 126c, 126d may be embodied in the form of a fixed axial shaft 127 extending from a reference structure of the teabag bagging machine and/or the base frame 131 of the thread tying module 120 such that the four levers 126a, 126b, 126c, 126d may be pivotably mounted to the fixed axial shaft 127. According to various embodiments, a rotation of the rotation shaft 122 may rotate the four cams 124a, 124b, 124c, 124d to generate a corresponding reciprocating (back and forth) motion in the four levers 126a, 126b, 126c, 126d. According to various embodiments, each of the four linkage mechanisms 130a, 130b, 130c, 130d may be connected to a respective second connection portion 129a, 129b, 129c, 129d

of a corresponding lever of the four levers 126a, 126b, 126c, 126d. According to various embodiments, each of the four linkage mechanisms 130a, 130b, 130c, 130d may include an assembly of links arranged and connected to a corresponding lever of the four levers 126a, 126b, 126c, 126d in a manner so as to transfer movements and forces from respective levers 126a, 126b, 126c, 126d to generate a desired motion of a corresponding linkage mechanism 130a, 130b, 130c, 130d.

[00027] According to various embodiments, in addition to the first linkage mechanism 130a and the second linkage mechanism 130b as described above, the thread tying module 120 may include a third linkage mechanism 130c. The third linkage mechanism 130c may be connected to the needle 142 of the needle assembly 140. According to various embodiments, the third linkage mechanism 130c may be configured to convert a lever motion of a third lever 126c into a corresponding rotation of the needle 142 about its longitudinal axis. Accordingly, the third linkage mechanism 130c may convert a reciprocating motion of the third lever 126c into a corresponding rotation of the needle 142 about its longitudinal axis. Hence, the third linkage mechanism 130c may transfer a movement of the third lever 126c based on a rotation of the third cam 124c to generate a desired rotation of the needle 142.

[00028] According to various embodiments, the third linkage mechanism 130c may be a spatial linkage mechanism. Accordingly, the links of the third linkage mechanism 130c may generate relative motions that are not in the same plane or in parallel planes. According to various embodiment, the third linkage mechanism 130c may include a third link rod 132c with a first connection portion connected to the second connection portion 129c of the third lever 126c. According to various embodiments, the third linkage mechanism 130c may further include a third rocker-arm-link 134c which has a pivot axis 133c lying in a plane perpendicular to the rotational axis 121 of the rotation shaft 122 and which has a first connection portion connected to a second connection portion of the third link rod 132c. According to various embodiments, the third linkage mechanism 130c may further include a third coupler link 136c with a first connection portion connected to a second connection portion of the third rocker-arm-link 134c. According to various embodiments, the third linkage mechanism 130c may further include a quadrant gear 138c with a pivot shaft 137c parallel to the pivot axis 133c of the third rocker-arm-link 134c and with a connection portion of the pivot shaft 137c connected to a second connection portion of the third coupler link 136c. According to various embodiments, the pivot axis 133c of the third rocker-arm-link 134c may be embodied in the form of an axial rod 135c fixed with respect to the reference structure of the teabag bagging machine and/or the base frame 131 of the thread tying module 120 such that the third rocker-

arm-link 134c may be pivotably mounted to the axial rods 135c. According to various embodiments, the needle 142 of the needle assembly 140 may include a gear in engagement with the quadrant gear 138c of the third linkage mechanism 130c.

[00029] According to various embodiments, the thread tying module 120 may further include the fourth linkage mechanism 130d. The fourth linkage mechanism 130d may be connected to the thread inserter 154 of the thread pusher assembly 150. According to various embodiments, the fourth linkage mechanism 130d may be configured to impart a rotation to the thread inserter 154 between a forward disposition, in which the second inserter arm 158 engages the thread 104 for pushing the same, and a retracted disposition, in which the second inserter arm 158 is disengaged from the thread 104. Accordingly, the fourth linkage mechanism 130d may transfer a movement of a fourth lever 126d based on a rotation of the fourth cam 124d to generate a desired movement of the thread inserter 154. According to various embodiments, the desired movement of the thread inserter 154 may be rotating between the forward disposition and the retracted disposition.

[00030] According to various embodiments, the fourth linkage mechanism 130d may be a planar linkage mechanism. Accordingly, the relative motions of the links of the fourth linkage mechanism 130d may be in the same plane or in parallel planes. According to various embodiments, the fourth linkage mechanism 130d may include a fourth link rod 132d with a first connection portion connected to the second connection portion 129d of the fourth lever 126d. According to various embodiments, the fourth linkage mechanism 130d may further include a fourth rocker-arm-link 134d which has a pivot axis 133d parallel to the rotational axis 121 of the rotation shaft 122 and which has a first connection portion connected to a second connection portion of the fourth link rod 132d. According to various embodiments, the fourth linkage mechanism 130d may further include a fourth coupler link 136d with a first connection portion connected to a second connection portion of the fourth rocker-arm-link 134d and a second connection portion connected to the thread inserter 154 in a manner so as to convert a linear motion of the fourth coupler link 136d to a rotation motion of the thread inserter 154. According to various embodiments, the pivot axis 133d of the fourth rocker-arm-link 134d may be embodied in the form of a pin joint coupling the fourth rocker-arm-link 134d to the teabag bagging machine and/or the base frame 131 of the thread tying module 120.

[00031] According to various embodiments, the thread tying module 120 may include a thread puller assembly 160 which, when seen in a direction of the rotational axis 121 of the rotation shaft 122, is arranged on an opposite side of the needle assembly 140 with respect to the thread pusher assembly 150, and is optionally arranged adjacent to the thread pusher

assembly 150. Accordingly, the thread pusher assembly 150 may be arranged to be between the needle assembly 140 and the thread puller assembly 160. According to various embodiments, the thread puller assembly 160 may include a tensioning spool 162 rotatable about a spool shaft (not shown) parallel to the rotational axis 121 of the rotation shaft 122, by which a pulling force may be applied to the thread 104 which extends from a reservoir spool 170 to between the needle assembly 140 and the thread pusher assembly 150, to the tensioning spool 162. According to various embodiments, the thread puller assembly 160 may include at least two thread receiving portions (see 464a, 464b of FIG. 4A) along the circumference of the tensioning spool 162. According to various embodiments, the at least two thread receiving portions 464a, 464b may be spaced equally along the circumference of the tensioning spool 162. According to various embodiments, each of the at least two thread receiving portions 464a, 464b of the tensioning spool 162 may include clamping elements configured to hold a leading end portion of the thread 104 from the reservoir spool 170.

[00032] Referring to the teabag conveying module 110 of the system 100, according to various embodiments, the at least one teabag receiving portion 112 of the teabag conveying module 110 may include a hook 470 (see FIG. 4A to FIG. 4L). According to various embodiments, when the teabag receiving portion 112 of the teabag conveying module 110 is in the knotting position and the thread pusher assembly 150 of the thread tying module 120 is in the forward disposition, the hook 470 of the teabag receiving portion 112 may be disposed with respect to the second inserter arm 158 of the thread inserter 154 of the thread pusher assembly 150 in a manner such that a direction of movement of the second inserter arm 158 of the thread inserter 154 may be toward the hook 470. According to various embodiments, the second inserter arm 158 of the thread inserter 154 may be configured to push a segment of the thread 104 so as to loop the segment of the thread 104 over the hook 470 of the teabag receiving portion 112 of the teabag conveying module 110.

[00033] According to various embodiments, the teabag conveying module 110 may include a wheel with said teabag receiving portion 112 along a circumference of the wheel. According to various embodiments, the wheel may be rotatable about a wheel rotational axis, which extends in parallel to the rotational axis 121 of the rotational shaft 122, to thereby allow the teabag receiving portion 112 to be placed in diverse angular positions with one of said angular positions corresponding to the knotting position of the teabag 102. According to various embodiments, the diverse angular positions may, in addition to the knotting position, include: a teabag receiving position, in which a teabag 102 may be placed on the teabag receiving portion; a thread cutting position, in which the thread attached to the teabag 102 may be cut so

as to be released from the reservoir spool 170; and a teabag removing position, in which a teabag 102 with a readily knotted thread may be removed from the wheel. According to various embodiments, the wheel may be rotatable about the wheel rotational axis with respect to the teabag bagging machine and/or the base frame 131 of the thread tying module 120.

[00034] According to various embodiments, the at least one teabag receiving portion 112 of the teabag conveying module 110 may be extending radially from the wheel. According to various embodiments, the at least one teabag receiving portion 112 of the teabag conveying module 110 may include a pair of grippers. The pair of grippers may be extending radially from the wheel. According to various embodiments, the hook 470 may be on one of the pair of grippers. According to various embodiments, the wheel may include a recessed portion along the circumference of the wheel and between the pair of grippers. According to various embodiments, the recessed portion may be shaped to correspond with a shape of a base of the teabag 102 such that the base of the teabag 102 may be placed into the recessed portion while an upper portion of the teabag 102 may be clamped by the pair of grippers so as to hold the teabag 102.

[00035] FIG. 3A to FIG. 3E shows a series of movements of the respective components of the thread tying module 120 in one revolution of the rotation shaft 122 according to various embodiments. Referring back to FIG. 1, FIG. 1 shows the respective components of the thread tying module 120 in the starting position. As shown in FIG. 1, a teabag 102 may be conveyed to a knotting position which is between the needle assembly 140 and the thread pusher assembly 150. Accordingly, the needle assembly 140 may be on one side of the teabag 102 and the thread pusher assembly 150 may be on an opposite side of the teabag 102. FIG. 3A shows a first set of movement of the thread tying module 120 according to various embodiments. As shown, the rotation shaft 122 may be rotated to cause the first cam 124a to generate a lever motion of the first lever 126a so as to impart a corresponding motion to the first linkage mechanism 130a to move the needle assembly 140 into the forward disposition. Further, the shaft 122 may be rotated to cause the second cam 124b to generate a lever motion of the second lever 126b so as to impart a corresponding motion to the second linkage mechanism 130b to move the thread pusher assembly 150 into the forward disposition. According to various embodiments, the first cam 124a and the second cam 124b may be configured such that the movement of the needle assembly 140 into the forward disposition and the movement of the thread pusher assembly 150 into the forward disposition may be synchronized. According to various embodiments, the first cam 124a and the second cam 124b may be configured such that the movement of the thread pusher assembly 150 into the forward

disposition and the movement of the needle assembly 140 into the forward disposition may be in sequence with the thread pusher assembly 150 being moved into the forward disposition first followed by moving the needle assembly 140 into the forward disposition. As shown, when both the needle assembly 140 and the thread pusher assembly 150 are in the respective forward disposition, the thread pusher head 152 of the thread pusher assembly 150 may engage and push the thread 104 towards the teabag 102, and the needle 142 of the needle assembly 140 may punch through the teabag 102 to engage with the thread 104 on the thread pusher head 152 of the thread pusher assembly 150. According to various embodiments, the thread pusher head 152 of the thread pusher assembly 150 may include an engagement surface which may push against a first side of the teabag 102. The engagement surface may include a groove in which the thread 104 may be received such that the thread 104 may be placed adjacent to the first side of the teabag 102. According to various embodiments, the needle 142 of the needle assembly 140 may punch through the teabag 102 (from a second side to the first side, wherein the second side is opposite to the first side) and be inserted into a hole of the engagement surface of the thread pusher head 152 such that a notch on the needle 142 may engage with the thread 104.

[00036] FIG. 3B shows a second set of movement of the thread tying module 120 according to various embodiments. As shown, the rotation shaft 122 may be rotated to cause the first cam 124a to generate a lever motion of the first lever 126a so as to impart a corresponding motion to the first linkage mechanism 130a to retract the needle assembly 140 into the intermediate disposition. Further, the rotation shaft 122 may be rotated to cause the third cam 124c to generate a lever motion of the third lever 126c which is converted into a corresponding rotation of the needle 142 of the needle assembly 140 about its longitudinal axis by the third linkage mechanism 130c. According to various embodiments, the first cam 124a and the third cam 124c may be configured such that the movement of the needle assembly 140 into the intermediate disposition and rotation of the needle 142 of the needle assembly 140 may be synchronized. According to various embodiments, the first cam 124a and the third cam 124c may be configured such that the movement of the needle assembly 140 into the intermediate disposition and rotation of the needle 142 of the needle assembly 140 may be in sequence with the needle assembly 140 being retracted to the intermediate disposition first followed by rotating the needle 142 of the needle assembly 140. According to various embodiments, as the needle assembly 140 is being retracted to the intermediate disposition from the forward disposition, the notch of the needle 142 of the needle assembly 140 may pull a first segment of the thread 104 through the teabag 102, from the first side to the second side, via a hole

previously punched by the needle 142 in the first set of movement, to form an open loop on the second side of the teabag 102. According to various embodiments, rotating the needle 142 of the needle assembly 140 with the notch of the needle 142 still holding on to the first segment of the thread 104 may twist the first segment of the thread 104 such that the first segment of the thread 104 may change from the open loop to an eye (or a closed loop).

[00037] While it is shown and described that the needle 142 of the needle assembly 140 may be rotated via the third cam 124c, the third lever 126c and the third linkage mechanism 130c, according to various other embodiments, the rotation of the needle 142 of the needle assembly 140 may be driven via other form of actuator such as servo motor or dc motor or pneumatic actuator or hydraulic actuator or other suitable actuator directly coupled to the needle 142. The actuator for the needle 142 of the needle assembly 140 may be activated upon detection of the needle assembly being retracted to the intermediate disposition from the forward disposition. According to various embodiments, detection of the movement of the needle assembly may be via suitable sensors such as contact sensors (e.g. limit switch), or non-contact sensors (e.g. infra-red sensor or proximity sensor).

[00038] FIG. 3C shows a third set of movement of the thread tying module 120 according to various embodiments. As shown, the rotation shaft 122 may be further rotated to cause the fourth cam 124d to generate a lever motion of the fourth lever 126d so as to impart a corresponding motion to the fourth linkage mechanism 130d to rotate the thread inserter 154 to the forward disposition such that the second inserter arm 158 of the thread inserter 154 may engage a second segment of the thread 104 and pushes the second segment of the thread 104. According to various embodiments, the second inserter arm 158 of the thread inserter 154 may push the second segment of the thread 104 over an edge of the teabag 102, from the first side to the second side, and insert an open loop of the second segment of the thread 104 through the eye of the thread 104 formed by the first segment of the thread 104. According to various embodiments, the second inserter arm 158 of the thread inserter 154 may further push the open loop of the second segment of the thread 104 and hang the open loop of the second segment of the thread 104 on the the hook 470 of the teabag receiving portion 112 of the teabag conveying module 110. According to various embodiments, the eye formed by the first segment of the thread 104 may be released from the notch of the needle 142 as the second inserter arm 158 of the thread inserter 154 is pushing the open loop of the second segment of the thread 104 through the eye formed by the first segment of the thread 104. According to various embodiments, the eye formed by the first segment of the thread 104 may be pushed off the the notch of the needle

142 via friction as the second inserter arm 158 of the thread inserter 154 moves through the eye formed by the first segment of the thread 104.

[00039] FIG. 3D shows a fourth set of movement of the thread tying module 120 according to various embodiments. As shown, the rotation shaft 122 may be further rotated to cause the fourth cam 124d to generate a lever motion of the fourth lever 126d so as to impart a corresponding motion to the fourth linkage mechanism 130d to rotate the thread inserter 154 to the retracted disposition such that the second inserter arm 158 of the thread inserter 154 may disengage from the second segment of the thread 104. Further, the rotation shaft 122 may be rotated to cause the first cam 124a to generate a lever motion of the first lever 126a so as to impart a corresponding motion to the first linkage mechanism 130a to further retract the needle assembly 140 into the retracted disposition. According to various embodiments, the first cam 124a and the fourth cam 124c may be configured such that the movement of the needle assembly 140 into the retracted disposition and rotation of the thread inserter 154 to the retracted disposition may be synchronized. According to various embodiments, the first cam 124a and the fourth cam 124c may be configured such that the movement of the needle assembly 140 into the retracted disposition and rotation of the thread inserter 154 to the retracted disposition may be in sequence in any order. According to various embodiments, the tensioning spool 162 of the thread puller assembly 160 may be rotated to tighten the eye formed by the first segment of the thread 104 so as to close the eye on the second segment of the thread 104 for holding closely the second segment of the thread 104 to the teabag 102.

[00040] FIG. 3E shows a fifth set of movement of the thread tying module 120 according to various embodiments. As shown the rotation shaft 122 may be further rotated to cause the second cam 124b to generate a lever motion of the second lever 126b so as to impart a corresponding motion to the second linkage mechanism 130b to retract the thread pusher assembly 150 into the retracted disposition. Upon retraction of the thread pusher assembly 150, one cycle of movements of the thread tying module 120 is completed. As shown, when the thread pusher assembly 150 is retracted, the thread 104 may be running from the tensioning spool 162 of the thread puller assembly 160 to the teabag 102 and from the teabag 120 to the reservoir spool 170. From this position, the teabag conveying module 110 may move the teabag 102 from the knotting position to the thread cutting position. As the teabag 102 is being moved by the teabag conveying module 110, the thread puller assembly 160 may also rotate to facilitate the movement of the teabag 102 and take in the slack of the thread 104 as the teabag 102 is being moved. Further, as the teabag 102 is being moved pass the thread puller assembly 160, an aft segment of the thread 104 between the teabag 102 and the reservoir spool 170 (i.e.

after the second segment of the thread 104) may come into contact with the thread puller assembly 160. According to various embodiments, the thread puller assembly 160 may be configured to catch a portion of the aft segment of the thread 104 when it is in contact with the thread puller assembly 160. Accordingly, a length of the thread 104 may again be extending directly from the thread puller assembly 160 to the reservoir spool such that the new length of thread 104 may be used for attaching to another teabag 102 by the thread tying module.

[00041] According to various embodiments, the teabag 102 which is in the thread cutting position may have the forward segment of the thread 104 running from the thread puller assembly 160 to the teabag 102 and the aft segment of the thread 104 running from the teabag 102 to the thread puller assembly 160. According to various embodiments, a cutter 180 may be configured to cut the aft segment of the thread 104 and the thread puller assembly 160 may release the forward segment of the thread 104 such that a standalone single piece of thread may be appended to the teabag 102. According to various embodiments, the teabag conveying module 110 may then move the teabag 102 into the teabag removing position such that the teabag 102 may be removed from the teabag receiving portion 112 of the teabag conveying module 110 to complete the process of attaching a piece of thread to the teabag 102.

[00042] FIG. 4A to FIG. 4L shows schematic diagrams of a method 401 of attaching a piece of thread to a teabag 102 according to various embodiments. According to various embodiments, the method 401 may be performed by the system 100 of FIG. 1 to FIG. 3E. FIG. 4A shows a starting arrangement of the method 401 according to various embodiments. As shown, according to various embodiments, in the starting arrangement, the teabag 102 may be held by the teabag receiving portion 112 of the teabag conveying module 110 and may be at the knotting position. In the knotting position, the thread 104 may be extending between the thread puller assembly 160 and the reservoir spool 170. According to various embodiments, the teabag receiving portion 112 of the teabag conveying module 110 may be a pair of teabag grippers 413a, 413b. According to various embodiments, the thread puller assembly 160 may include the tensioning spool 162 and the at least two thread receiving portions 464a, 464b. Further, the first thread receiving portion 464a may be holding a leading end of the thread 104. As shown, according to various embodiments, in the knotting position, the teabag 102 may be placed between the thread 104 and the needle 142 of the needle assembly 140. Accordingly, the thread 104 may be on a first side 403 of the teabag 102 and the needle 142 of the needle assembly 140 may be on a second side 405 of the teabag 102.

[00043] FIG. 4B shows that the method 401 may include punching the needle 142 through the teabag 102 from the second side 405 to the first side 403 according to various embodiments.

According to various embodiments, the needle 142 may punch through a tip portion of the teabag 102. Further, the method 401 may include hooking, via a notch 441 in the needle 142 inserted through the teabag 102, a first mid-segment 482 of a continuous portion of a thread 104 adjacent to the first side 403 of the teabag 102 according to various embodiments. Accordingly, the needle 142 may be operated to punch through the teabag 102 and be inserted in a manner such that the notch 441 of the needle 142 hooks onto the first mid-segment 482 of the continuous portion of the thread 104. According to various embodiments, the above steps of method 401 may be performed by the first set of movement of thread tying module 120 of the system 100 as shown in FIG. 3A.

[00044] FIG. 4C shows that the method 401 may further include running the needle 142 through the teabag 102 along with the first mid-segment 482 of the thread 104 to a second side 405 of the teabag 102 opposite the first side 403 according to various embodiments. Accordingly, the needle 142 may pull the first mid-segment 482 of the thread 104 through the hole, which is previously punctured by the needle 142, from the first side 403 to the second side 405 of the teabag 102. Hence, the first mid-segment 482 of the thread 104 may form an open loop of thread on the second side 405 of the teabag 102.

[00045] FIG. 4D shows that the method 401 may further include rotating the needle 142 about its longitudinal axis to make an eye extending from the second side 405 with the first mid-segment 482 of the thread 104 according to various embodiments. Accordingly, rotating the needle 142 about its longitudinal axis may twist the open loop of the first mid-segment 482 to form the eye (or the closed loop) on the second side 405 of the teabag 102. According to various embodiments, the steps of the method 401 as shown in FIG. 4C and the above step of the method 401 as shown in FIG. 4D may be performed by the second set of movement of thread tying module 120 of the system 100 as shown in FIG. 3B. According to various embodiments, rotating the needle about its longitudinal axis may include rotating the needle 450° +/- 5° about its longitudinal axis.

[00046] Further, FIG. 4D shows that the method 401 may include moving a thread inserter 454 towards a second mid-segment 484 of the continuous portion of the thread 104 for engaging with the second mid-segment 484 of the thread 104. According to various embodiments, the thread inserter 454 may be the thread inserter 154 of the thread tying module 120 of FIG. 1 to FIG. 3E. Accordingly, the second inserter arm 158 may be the part of the thread inserter 154 that engages with the second mid-segment 484 of the thread 104.

[00047] FIG. 4E shows that the method 401 may further include pushing, via the thread inserter 454, the second mid-segment 484 of the continuous portion of the thread 104 over an

edge 406 of the teabag 102 from the first side 403 to the second side 405, and inserting an open loop of the second mid-segment 484 through the eye formed by the first mid-segment 482 according to various embodiments. According to various embodiments, the edge 406 of the teabag 102 may be an edge of the tip portion of the teabag 102. FIG. 4F shows that the method 401 may further include hanging the loop of the second mid-segment 484 on a hook 470 of the teabag gripper 413a at the second side 405 of the teabag 102 according to various embodiments. Further, as also shown, the eye formed by the first mid-segment 482 may be released from the notch 441 of the needle 142 according to various embodiments. According to various embodiments, the steps of the method 401 as shown in FIG. 4E and the above step of the method 401 as shown in FIG. 4F may be performed by the third set of movement of thread tying module 120 of the system 100 as shown in FIG. 3C. According to various embodiments, releasing the eye from the notch 441 of the needle 142 may include pushing the eye off the notch 441 of the needle 142 via friction as the thread inserter 454 moves through the eye formed by the first mid-segment 482.

[00048] FIG. 4F also shows the method 401 may further include retracting the needle 142 after the eye formed by the first mid-segment 482 is released from the notch 441 of the needle 142 according to various embodiments. FIG. 4G shows that the method 401 may further include retracting the thread inserter 454 after the hanging the loop of the second mid-segment 484 on the hook 470 of the teabag gripper 413a. FIG. 4H and FIG. 4I show that the method 401 may further include pulling, via the thread puller assembly 160, a forward segment of the continuous portion of the thread 104 before the first mid-segment 482 so as to tighten the eye formed by the first mid-segment 482. According to various embodiments, the forward segment of the continuous portion of the thread 104 may be clamped to the thread puller assembly 160 via the first thread receiving portion 464a. According to various embodiments, the method 401 may include rotating the tensioning spool 162 of the thread puller assembly160 to tighten the eye formed by the first mid-segment 482 of the thread 104 so as to close the eye on the second mid-segment 484 of the thread 104 for holding closely the second mid-segment 484 of the thread 104 to the teabag 102. According to various embodiments, the above step of the method 401 as shown in FIG. 4F and the steps of the method 401 as shown in FIG. 4G to FIG. 4I may be performed by the fourth set of movement of thread tying module 120 of the system 100 as shown in FIG. 3D.

[00049] FIG. 4J shows that the method 401 may further include moving the teabag 102 from the knotting position to a thread cutting position by the teabag conveying module 110 according to various embodiments. According to various embodiments, in the thread cutting position, an

aft segment of continuous portion of the thread 104 between the teabag 102 and the reservoir spool 170 (i.e. after the second mid-segment 484 of the thread 104) may come into contact with the thread puller assembly 160. According to various embodiments, the thread puller assembly 160 may be configured to catch a portion of the aft segment of the thread 104, via the second thread receiving portion 464b, when it is in contact with the thread puller assembly 160. Accordingly, the method 401 may further include clamping the aft segment of the continuous portion of the thread 104 to the thread puller assembly 160 prior to cutting the thread 104. Hence, a new length of the thread 104 may again be extending directly from the second thread receiving portion 464b of the thread puller assembly 160 to the reservoir spool 170 such that the new length of thread 104 may be used for attaching to another teabag 102 by the thread tying module 120.

[00050] FIG. 4K shows that the method 401 may further include cutting the thread 104 along the aft segment of the continuous portion of the thread 104 after the second mid-segment 484 according to various embodiments. As shown, according to various embodiments, when the teabag 102 is in the thread cutting position, the forward segment of the thread 104 may run from the thread puller assembly 160 to the teabag 102 and the aft segment of the thread 104 may run from the teabag 102 to the thread puller assembly 160. According to various embodiments, a cutter 180 may cut the aft segment of the thread 104. According to various embodiments, cutting the thread 104 may include cutting the thread 104 after the second mid-segment 484 and before the clamped aft segment.

[00051] FIG. 4L shows that the method 401 may further include removing the teabag 102 from the pair of teabag grippers 413a, 413b in a manner so as to pull the second mid-segment 484 through the hook 470 of the teabag gripper 413a such that a cut-end of the thread is correspondingly pulled through the eye formed by the first mid-segment 482 before being pulled through the hook 470 of the teabag gripper 413a. Further, the method 401 may further include releasing the clamped forward segment of the continuous portion of the thread 104 as the teabag 102 is removed from the pair of teabag grippers 413a, 413b. Accordingly, the thread puller assembly 160 may release the forward segment of the thread 104 such that a standalone single piece of thread may be appended to the teabag 102. According to various embodiments, the method 401 may provide a complete process of attaching a piece of thread to the teabag 102. According to various embodiments, the steps of the method 401 as shown in FIG. 4J to FIG. 4L may be performed by the movement of the system 100 as shown in FIG. 3E.

[00052] Various embodiments relate to a tagging module for a teabag bagging machine. According to various embodiments, the tagging module may be configured to be installed in a

teabag bagging machine so as to attach a tag to a thread from a teabag (i.e. without using staples). According to various embodiments, the tagging module may be configured to be installed on an existing conventional teabag bagging machine, which uses staples, so as to convert the existing teabag bagging machine into one which does not use staple. Accordingly, the tagging module may be configured to be an attachment unit for direct installation on an existing conventional teabag bagging machine. According to various embodiments, the tagging module may be configured to replace a staple module in the existing conventional teabag bagging machine. According to various embodiments, the tagging module may also be configured to be installed in a new teabag bagging machine.

[00053] FIG. 5A shows a schematic diagram of a system 500 for attaching a tag 506 to a piece of thread 504 from a teabag 502 according to various embodiments. FIG. 5B shows a close up view of a tagging position of the system 500 of FIG. 5A according to various embodiments. As shown, the system 500 may include a threaded-teabag conveying module 510 and a needling module 520. According to various embodiments, the threaded-teabag conveying module 510 may be configured to convey the teabag 502, which has the piece of thread 504 attached to the teabag 502, to a tag attachment position with respect to the needling module 520 so as to attach the tag 506 to the piece of thread 504 of the teabag 502. According to various embodiments, the threaded-teabag conveying module 510 may include at least one threaded-teabag receiving portion 512 configured to retain the threaded-teabag 502 that is to be conveyed by the threaded-teabag conveying module 510. According to various embodiments, at least one threaded-teabag receiving portion 512 of the threaded-teabag conveying module 510 may also be configured to receive a tag in a manner so as to place a tag over a segment of the piece of thread 504 attached to the threaded-teabag 502. According to various embodiments, the threaded-teabag conveying module 510 may include a plurality of threaded-teabag receiving portions 512. According to various embodiments, the threaded-teabag conveying module 510 may be mounted on a teabag bagging machine. According to various embodiments, the threaded-teabag conveying module 510 may be part of an existing teabag bagging machine.

[00054] According to various embodiments, the threaded-teabag conveying module 510 may include a wheel with said threaded-teabag receiving portion 512 along a circumference of the wheel. According to various embodiments, the wheel may be rotatable about a wheel rotational axis to thereby allow the threaded-teabag receiving portion 512 to be placed in diverse angular positions with one of said angular positions corresponding to the tag attachment position. According to various embodiments, the diverse angular positions may, in addition to the tag

attachment position, include: a threaded-teabag receiving position, in which the threaded-teabag 502 may be placed on the threaded-teabag receiving portion 512; a tag receiving position, in which the tag 506 may be placed together with the threaded-teabag; and a threaded-teabag removing position, in which the threaded-teabag 502 with the tag 506 attached to the thread 504 of the teabag 502 may be removed from the wheel.

[00055] According to various embodiments, the at least one threaded-teabag receiving portion 512 of the threaded-teabag conveying module 510 may be extending radially from the wheel. According to various embodiments, the at least one threaded-teabag receiving portion 512 of the threaded-teabag conveying module 510 may include a pair of grippers. The pair of grippers may be extending radially from the wheel.

[00056] According to various embodiments, the needling module 520 may be configured to be mounted to a teabag bagging machine. Accordingly, the needling module 520 may be configured to be mounted to a frame or a support structure or a casing or a housing of the teabag bagging machine. According to various embodiments, various components of the needling module 520 may be directly mounted to the frame or the support structure or the casing or the housing of the teabag bagging machine. According to various embodiments, the needling module 520 may include a base frame 531 on which the various components of the needling module 520 may be fitted. Accordingly, the needling module 520 may be in the form of a single unit which may be mounted to the teabag bagging machine by mounting the base frame 531 to the teabag bagging machine. According to various embodiments, the needling module 520 may include a rotation shaft 522 configured to be coupled to a driving mechanism in a manner so as to be driven by the driving mechanism. According to various embodiments, the driving mechanism may be a driving shaft of the teabag bagging machine. According to various embodiments, the driving mechanism may be an external motor which is configured to synchronise with the movements of the teabag bagging machine. According to various embodiments, the rotation shaft 522 may be coupled to the driving mechanism via shaft couplings, or gears, or chains, or belts, or a combination thereof. According to various embodiments, the rotation shaft 522 may be rotatable with respect to the teabag bagging machine and/or the base frame 531.

[00057] According to various embodiments, the needling module 520 may include a first cam 524a and a second cam 524b fixedly joined to the rotation shaft 522 such that the first and second cams 524a, 524b may rotate together with the rotation shaft 522. According to various embodiments, each of the first and second cams 524a, 524b may be a disc cam, a plate cam, or a face cam. According to various embodiments, the disc cam or the plate cam may include an

eccentric wheel. According to various embodiments, the face cam may include a disc with a slot or groove forming a closed curve on a face of the disc. According to various embodiments, the needling module 520 may include a first lever 526a and a second lever 526b. According to various embodiments, each of the first and second levers 526a, 526b may have a first connection portion (e.g. 528a) in engagement with a corresponding cam of said cams 524a, 524b. According to various embodiments, the first connection portion of respective lever 526a, 526b may include an end portion or an end of the respective lever 526a, 526b. According to various embodiments, the first lever 526a may have a pivot axis 525a parallel to a rotational axis 521 of the rotation shaft 522. According to various embodiments, the second lever 526b may have a pivot axis 525b perpendicular to the pivot axis 525a of the first lever 526a. According to various embodiments, respective pivot axis 525a, 525b of the first and second levers 526a, 526b may be embodied in the form of a corresponding fixed axial shaft 527a, 527b extending from a reference structure of the teabag bagging machine and/or the base frame 531 of the needling module 520 such that the first and second levers 526a, 526b may be pivotably mounted to the respective fixed axial shaft 527a, 527b. According to various embodiments, a rotation of the rotation shaft 522 may rotate the respective cams 524a, 524b, to generate a corresponding reciprocating (back and forth) motion in a corresponding lever 526a, 526b.

[00058] According to various embodiments, the needling module 520 may include a needle 542 and a needle shank 544. According to various embodiments, the needle 542 may be integral with the needle shank 544 such that the needle 542 and the needle shank 544 may be rotatable together as a whole about a longitudinal axis and movable together as a whole along the longitudinal axis. According to various embodiments, the needle 542 and the needle shank 544 may be arranged to lie in a first plane (or a needle's plane) at least substantially perpendicular to the rotational axis 521 of the rotation shaft 522. According to various embodiments, the needle shank 544 may include a first cylindrical portion 546 and a second cylindrical portion 548. According to various embodiments, the second cylindrical portion 548 may be between the first cylindrical portion 546 and the needle 542. Accordingly, the needle 542 may be extending longitudinally from a first end of the second cylindrical portion 548 and the first cylindrical portion 546 may be extending longitudinally from a second end of the second cylindrical portion 548.

[00059] According to various embodiments, the first cylindrical portion 546 of the needle shank 544 may be slidably received in a guide member 599 which may be fixed with respect to the teabag bagging machine and/or the base frame 531. Accordingly, the needle 542 and the needle shank 544 may be slidable together as a whole with respect to the guide member 599

along the longitudinal axis. According to various embodiments, the first cylindrical portion 546 of the needle shank 544 may include a circumferential groove 545 (or slot). Accordingly to various embodiments, a second connection portion of the first lever 526a may be received within the circumferential groove 545 of the first cylindrical portion 546 such that a rotating motion of the first cam 524a may move the first lever 526a in a manner so as to impart a corresponding sliding motion to the needle shank 544 along the longitudinal axis.

[00060] According to various embodiments, the second cylindrical portion 548 may include a plurality of teeth or groove 549 with respective tooth-line or groove-line aligned straight and parallel to a longitudinal extension of the second cylindrical portion 548. According to various embodiments, a second connection portion of the second lever 526a may be connected to a link 530 having a series of tooth-like protrusions distributed along its axial direction with respective tooth-line aligned perpendicular to the axial direction. The tooth-like protrusions of the link 530 may engage with the plurality of teeth or groove 549 of the second cylindrical portion 548 such that a rotating motion of the second cam 524b may move the second lever 526b in a manner so as to impart a corresponding linear motion to the link 530 in engagement with the second cylindrical portion 548 to rotate the needle shank 544 about its longitudinal axis. According to various embodiments, the engagement between the link 530 and the second cylindrical portion 548 may be similar to a rack and pinion mechanism.

[00061] While it is shown and described that the needle 542 may be moved axially via the first cam 524a and the first lever 526a, according to various other embodiments, the axial movement of the needle 542 may be driven via other form of actuator such as servo motor or dc motor or pneumatic actuator or hydraulic actuator or other suitable actuator. Similarly, while it is shown and described that the needle 542 may be rotated via the second cam 524b, the second lever 526b, and the link 530, according to various other embodiments, the rotation of the needle 542 may be driven via other form of actuator such as servo motor or dc motor or pneumatic actuator or hydraulic actuator or other suitable actuator. According to various embodiments, the respective actuator for respective axial movement or rotation of the needle 542 may be activated upon sensor feedback or by time-based controller.

[00062] FIG. 6A to FIG. 6G shows schematic diagrams of a method 601 of attaching a tag 506 to a piece of thread 504 of a teabag 502 according to various embodiments. According to various embodiments, the method 601 may be performed by the system 500 of FIG. 5A and FIG. 5B. FIG. 6A shows a starting arrangement of the system 500 and/or the method 601 according to various embodiments.

[00063] According to various embodiment, the system 500 for attaching a tag 506 to a piece of thread 504 of a teabag 502 may include the needle 542 configured to be rotatable about its longitudinal axis and configured to be movable in its axial directions. The system 500 may further include the threaded-teabag conveying module 510 configured to convey the threaded-teabag 502 to the tag attachment position with respect to the needle 542 so as to attach the tag 506 to the piece of thread 504 on the teabag 502. According to various embodiments, the threaded-teabag conveying module 510 may include at least one threaded-teabag receiving portion 512 having a tag-receiving surface 514 and a cavity 516 in the tag-receiving surface 514. According to various embodiments, when the at least one threaded-teabag receiving portion 512 is in the tag attachment position, the cavity 516 of the tag-receiving surface 514 may be aligned with the needle 542 in a manner such that axial movement of the needle 542 may insert a tip of the needle 542 into the cavity 516 of the tag-receiving surface 514. According to various embodiments, the system 500 may further include a tag pusher 590. According to various embodiments, when the at least one threaded-teabag receiving portion 512 is in the tag attachment position, the tag pusher 590 may be aligned to the tag-receiving surface 514 of the at least one threaded-teabag receiving portion 512 in a manner so as to push the tag 506 along the tag-receiving surface 514. According to various embodiments, the system 500 may further include a thread-clip 592. According to various embodiments, when the at least one threaded-teabag receiving portion 512 is in the tag attachment portion, the thread-clip 592 may be configured to hold a segment of the piece of thread 504 against a portion of the at least one threaded-teabag receiving portion 512. According to various embodiments, the thread-clip 592 may be a spring plate or a leaf spring or a spring clip.

[00064] According to various embodiments, in the starting arrangement of the method 601, the threaded-teabag 502 may be received on the at least on threaded-teabag receiving portion 512 in a manner so as to line the piece of thread 504 across the cavity 516 of the tag-receiving surface 514 and be held by the thread-clip 592 against a portion of the at least one threaded-teabag receiving portion 512. Further, the tag 506 may be rested on the tag-receiving surface 514 of the at least one threaded-teabag receiving portion 512 in a manner so as to sandwich the piece of thread 504 between the tag 506 and the tag-receiving surface 514 of the at least one threaded-teabag receiving portion 512, and to conceal the cavity 516 of the tag-receiving surface 514. Referring to FIG. 5B, according to various embodiments, the piece of thread 504 may have gone one round around the threaded-teabag 502, from the tip portion to the base and back to the tip portion, before extending away from the tip portion of the threaded-teabag 502 to be held by the thread-clip 592.

[00065] FIG. 6B shows that the method 601 may include punching the needle 542 through the tag 506 from the first side 605 to the second side 607 according to various embodiments. According to various embodiments, the needle 542 may punch through a tip portion of the tag 506. Further, the method 601 may include hooking, via a notch 541 in the needle 542 inserted through the tag 506, a first mid-segment 682 of the piece of thread 504 adjacent (see FIG. 6C) to the second side 507 of the tag 506 according to various embodiments. Accordingly, the needle 542 may be operated to punch through the tag 506 and be inserted into the cavity 516 of the tag-receiving surface 514 in a manner such that the notch 541 of the needle 542 may hook onto the first mid-segment 682 of the piece of the thread 504.

[00066] FIG. 6C shows that the method 601 may further include running the needle 542 through the tag 506 along with the first mid-segment 682 of the thread 504 to the first side 605 of the tag 506 opposite the second side 607 according to various embodiments. Accordingly, the needle 542 may pull the first mid-segment 682 of the thread 504 through the hole in the tag 506, which is previously punctured by the needle 542, from the second side 607 to the first side 605 of the tag 506. Hence, the first mid-segment 682 of the thread 504 may form an open loop of thread 504 on the first side 605 of the tag 506.

[00067] FIG. 6D shows that the method 601 may further include rotating the needle 542 about its longitudinal axis to make an eye extending from the first side 605 with the first mid-segment 682 of the thread 504 according to various embodiments. Accordingly, rotating the needle 542 about its longitudinal axis may twist the open loop of the first mid-segment 682 to form the eye (or the closed loop) on the first side 605 of the tag 506. According to various embodiments, rotating the needle 542 about its longitudinal axis may include rotating the needle 450° +/- 5° about its longitudinal axis.

[00068] FIG. 6E shows that the method 601 may further include pushing, via the tag pusher 590, the tag 506 along the tag-receiving surface 514 of the at least one threaded-teabag receiving portion 512 in a manner so as to move the tag 506 away from the cavity 516 of the tag-receiving surface 514 such that the tag 506 is not covering over the cavity 516 of the tag-receiving surface 514 according to various embodiments. Accordingly, the tag 506 may be moved by the tag pusher 590 to expose the cavity 516 of the tag-receiving surface 514 outside a perimeter of the tag 506 such that the needle 542 may be re-inserted into the cavity 516 without punching through the tag 506.

[00069] FIG. 6F shows that the method 601 may further include retracting the tag pusher 590 to expose the cavity 516 of the tag-receiving surface 514 according to various embodiments. FIG. 6F further shows that the method 601 may further include re-inserting the needle 542 into

the cavity 516 of the tag-receiving surface 514 according to various embodiments. Further, the method 601 may include hooking, via the notch 541 in the needle 542 inserted into the cavity 516, a second mid-segment 684 of the piece of thread 504 according to various embodiments. Accordingly, the needle 542 may be operated be inserted into the cavity 516 of the tag-receiving surface 514 in a manner such that the notch 541 of the needle 542 may hook onto the second mid-segment 684 of the piece of the thread 504.

[00070] FIG. 6G shows that the method 601 may further include running the needle 542 through the eye formed by the first mid-segment 682 along with the second mid-segment 684 of the thread 504 until an end of the piece of thread 504 correspondingly followed through the eye formed by the first mid-segment 682 according to various embodiments.

[00071] According to various embodiments, the method 601 may provide a complete process of attaching the tag 506 to the piece of thread 504 of the teabag 502.

[00072] FIG. 7 shows a schematic diagram of a system 700 for attaching a tag 706 to a piece of thread 704 from a teabag 702 according to various embodiments. As shown, the system 700 may include a threaded-teabag conveying module 710 and a heat-seal-tagging arrangement 720. According to various embodiments, the threaded-teabag conveying module 710 may be configured to convey the teabag 702, which has the piece of thread 704 attached to the teabag 702, to a tag attachment position with respect to the heat-seal-tagging arrangement 720 so as to attach the tag 706 to the piece of thread 704 of the teabag 702. According to various embodiments, the threaded-teabag conveying module 710 may include at least one threaded-teabag receiving portion 712 configured to retain the threaded-teabag 702 that is to be conveyed by the threaded-teabag conveying module 710. According to various embodiments, the at least one threaded-teabag receiving portion 712 of the threaded-teabag conveying module 710 may also be configured to receive a tag in a manner so as to place a tag over a segment of the piece of thread 704 attached to the threaded-teabag 702. According to various embodiments, the threaded-teabag conveying module 710 may include a plurality of threaded-teabag receiving portions 712. According to various embodiments, the threaded-teabag conveying module 710 may be mounted on a teabag bagging machine. According to various embodiments, the threaded-teabag conveying module 710 may be part of an existing teabag bagging machine.

[00073] According to various embodiments, the threaded-teabag conveying module 710 may include a wheel with said threaded-teabag receiving portion 712 along a circumference of the wheel. According to various embodiments, the wheel may be rotatable about a wheel rotational axis to thereby allow the threaded-teabag receiving portion 712 to be placed in diverse angular positions with one of said angular positions corresponding to the tag attachment position.

According to various embodiments, the diverse angular positions may, in addition to the tag attachment position, include: a threaded-teabag receiving position, in which the threaded-teabag 702 may be placed on the threaded-teabag receiving portion 712; a tag receiving position, in which the tag 706 may be placed together with the threaded-teabag 702; and a threaded- teabag removing position, in which the threaded-teabag 702 with the tag 706 attached to the thread 704 of the teabag 702 may be removed from the wheel.

[00074] According to various embodiments, the at least one threaded-teabag receiving portion 712 of the threaded-teabag conveying module 710 may be extending radially from the wheel. According to various embodiments, the at least one threaded-teabag receiving portion 712 of the threaded-teabag conveying module 710 may include a pair of grippers. The pair of grippers may be extending radially from the wheel.

[00075] According to various embodiments, the heat-seal-tagging arrangement 720 may include a thread puller 760 configured to pull a leading segment of the piece of thread 704 over an edge of the tag 706. According to various embodiments, the heat-seal-tagging arrangement 720 may further include a thread guide 764 configured to fold the leading segment of the piece of thread 704 in a manner so as to place the leading segment of the piece of thread 704 over an adhesive portion 709 of the tag 706. According to various embodiments, the heat-seal-tagging arrangement 720 may further include a pair of jaws 766 configured to clamp the folded piece of thread 704 and the tag 706 therebetween. According to various embodiments, the heat-seal-tagging arrangement 720 may further include a heating element coupled to one or both the jaws in a manner so as to heat the adhesive portion 709 of the tag 706 to bind the piece of thread 704 to the tag 706.

[00076] FIG. 8A to FIG. 8E shows schematic diagrams of a method 801 of attaching the tag 706 to the piece of thread 704 of the threaded-teabag 702 according to various embodiments. According to various embodiments, the method 801 may be performed by the system 700 of FIG. 7. FIG. 8A shows a starting arrangement of the method 801 according to various embodiments. According to various embodiments, in the starting arrangement of the method 801 when the threaded-teabag 702 reaches the tag attachment position, the threaded-teabag 702 may be on the at least on threaded-teabag receiving portion 712 with the leading segment of the piece of thread 704 extending away from a tip portion of the threaded-teabag 702. Further, the tag 706 may be rested on the leading segment of the piece of thread 704 with a first side 705 of the tag 706, which is opposite a second side 707 of the tag 706 having the adhesive portion 709, in contact with the leading segment of the piece of thread 704. According to various embodiments, the piece of thread 704 may have gone one round around the threaded-

teabag 702, from the tip portion to the base and back to the tip portion, before extending away from the tip portion of the threaded-teabag 702.

[00077] FIG. 8B shows that the method 801 may include pulling, via the thread puller 760, the leading segment of the piece of thread 704 over an edge of the tag 706. According to various embodiments, the thread puller 760 may be configured to be movable in a direction perpendicular to the sides of the tag 706. FIG. 8C shows that the method 801 may further include folding, via the thread guide 764, the leading segment of the piece of thread 704 to place the leading segment of the piece of thread 704 over an adhesive portion 709 of the tag 706 on the second side 707 of the tag 706. According to various embodiments, the thread guide 764 may be configured to be movable in a direction parallel to the second side 707 of the tag 706. FIG. 8D shows that the method 801 may include clamping, via the pair of jaws 766, the leading segment of the piece of thread 704 to the tag 706 and applying heat so as to bind the piece of thread 704 to the tag 706 at the adhesive portion 709 of the tag 706. According to various embodiments, the heating element of the pair of jaws 766 may be disposed in a manner so as to heat the adhesive portion 709 of the tag 706 such that the leading segment of the piece of thread 704 lying on the adhesive portion 709 may be bound to the tag 706 via the heated adhesive portion 709. FIG. 8E shows the tag 706 being bound to the piece of thread 704 of the teabag 702 according to various embodiments.

[00078] The following examples pertain to various embodiments

[00079] Example 1 is a thread tying module configured to be mounted to a teabag bagging machine, the module including:

a rotation shaft configured to be coupled to a driving mechanism;

two or more cams fixedly joined to the rotation shaft such that the two or more cams rotate together with the rotation shaft;

two or more levers, each lever having a first connection portion in engagement with a corresponding cam of said cams, and having a pivot axis parallel to a rotational axis of the rotation shaft;

two or more linkage mechanisms, each linkage mechanism connected to a respective second connection portion of a corresponding lever of said levers;

a needle assembly including a needle and a needle holder, the needle configured to be rotatable about its longitudinal axis with respect to the needle holder, the needle holder being connected to a first linkage mechanism of the linkage mechanisms, configured to impart a translation motion to the needle assembly in a plane perpendicular to the rotational axis of the rotation shaft so as to move the needle

assembly between a forward disposition, an intermediate disposition and a retracted disposition;

a thread pusher assembly including a thread pusher head and a thread inserter which is formed as an angular piece having a first inserter arm which is pivotably mounted to the thread pusher head with a pivot axis parallel to the rotational axis of the rotation shaft, and having a second inserter arm which is arc-shaped and extends in an angle relative to the first inserter arm, wherein the thread pusher head is connected to a second linkage mechanism of the linkage mechanisms, configured to impart a translation motion to the thread pusher assembly in the plane perpendicular to the rotational axis of the rotation shaft so as to move the thread pusher assembly between a forward disposition and a retracted disposition,

wherein the needle assembly and the thread pusher assembly are arranged in a manner such that, when both the assemblies are in the respective forward disposition, the thread pusher head of the thread pusher assembly engages and pushes a thread towards the needle assembly, and the needle assembly engages with the thread on the thread pusher head of the thread pusher assembly.

[00080] In Example 2, the subject matter of Example 1 may optionally include that the needle assembly and the thread pusher assembly may be arranged in a manner in which translation motions thereof are in directions in a range of 90° +/-10° relative to each other.

[00081] In Example 3, the subject matter of Example 1 or 2 may optionally include that the first linkage mechanism may be a planar linkage mechanism, and wherein the first linkage mechanism may include

a first link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a first rocker-arm-link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the first link rod,

a first coupler link with a first connection portion connected to a second connection portion of the first rocker-arm-link, and

a first follower link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the first coupler link,

wherein the needle holder may be connected to the first coupler link with the needle arranged with its longitudinal axis extending parallel to a longitudinal extension of the first coupler link.

[00082] In Example 4, the subject matter of any one of Examples 1 to 3 may optionally include that the second linkage mechanism may be a planar linkage mechanism, and wherein the second linkage mechanism may include

a second link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a second rocker-arm-link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the second link rod,

a second coupler link with a first connection portion connected to a second connection portion of the second rocker-arm-link, and

a second follower link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the second coupler link,

wherein the thread pusher head may be connected to the second coupler link.

[00083] In Example 5, the subject matter of Example 4 in combination with Example 3 may optionally include that the first coupler link and the second coupler link longitudinally extend in directions in a range of 90° +/-10° relative to each other.

[00084] In Example 6, the subject matter of any one of Examples 1 to 5 may optionally include that the two or more cams may include four cams, the two or more levers may include four levers, and the two or more linkage mechanisms may include four linkage mechanisms.

[00085] In Example 7, the subject matter of Example 6 may optionally include that the needle of the needle assembly may be connected to a third linkage mechanism of the linkage mechanisms, configured to convert a lever motion of the corresponding lever into a corresponding rotation of the needle about its longitudinal axis.

[00086] In Example 8, the subject matter of Example 7 may optionally include that the third linkage mechanism may be a spatial linkage mechanism, and wherein the third linkage mechanism may include

a third link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a third rocker-arm-link which has a pivot axis lying in another plane perpendicular to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the third link rod,

a third coupler link with a first connection portion connected to a second connection portion of the third rocker-arm-link, and

a quadrant gear with a pivot shaft parallel to the pivot axis of the third rocker-arm-link and with a connection portion of the pivot shaft connected to a second connection portion of the third coupler link,

wherein the needle may include a gear in engagement with the quadrant gear.

[00087] In Example 9, the subject matter of any one of Examples 6 to 8 may optionally include that the thread inserter of the thread pusher assembly may be connected to a fourth linkage mechanism of the linkage mechanisms, configured to impart a rotation to the thread inserter between a forward disposition, in which the second inserter arm engages the thread for pushing the same, and a retracted disposition, in which the second inserter arm is disengaged from the thread.

[00088] In Example 10, the subject matter of Example 9 may optionally include that the fourth linkage mechanism may be a planar linkage mechanism, and wherein the fourth linkage mechanism may include

a fourth link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a fourth rocker-arm-link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the fourth link rod, and

a fourth coupler link with a first connection portion connected to a second connection portion of the fourth rocker-arm-link and a second connection portion connected to the thread inserter in a manner so as to convert a linear motion of the fourth coupler link to a rotation motion of the thread inserter.

[00089] In Example 11, the subject matter of any one of Examples 1 to 10 may optionally include a thread puller assembly which, when seen in a direction of the rotational axis of the rotation shaft, is arranged on an opposite side of the needle assembly with respect to the thread pusher assembly, and is optionally arranged adjacent to the thread pusher assembly, wherein the thread puller assembly may include a tensioning spool rotatable about a spool shaft parallel to the rotational axis of the rotation shaft, by which the tensioning spool is operable to apply a

pulling force to the thread which extends from a reservoir spool to between the needle assembly and the thread pusher assembly, to the tensioning spool.

[00090] Example 12 is a system for attaching a piece of thread to a teabag, the system including:

the thread tying module of anyone of Examples 1 to 11; and

a teabag conveying module configured to convey the teabag to a knotting position with respect to the thread tying module so as to attach the piece of thread to the teabag,

wherein the teabag conveying module comprises at least one teabag receiving portion having a hook,

wherein, when said teabag receiving portion of the teabag conveying module is in the knotting position and the thread pusher assembly of the thread tying module is in the forward disposition, the hook of the teabag receiving portion is disposed with respect to the second inserter arm of the thread inserter of the thread pusher assembly in a manner such that a direction of movement of the second inserter arm of the thread inserter is toward the hook.

[00091] In Example 13, the subject matter of Example 12 may optionally include that the teabag conveying module may include a wheel with said teabag receiving portion along a circumference of the wheel, the wheel being rotatable about a wheel rotational axis, which extends in parallel to the rotational shaft, to thereby allow the teabag receiving portion to be placed in diverse angular positions with one of said angular positions corresponding to the knotting position of the teabag.

[00092] In Example 14, the subject matter of Example 12 or 13 may optionally include that said teabag receiving portion may include a pair of grippers, wherein the hook is on one of the pair of grippers.

[00093] Example 15 is a method of attaching a piece of thread to a teabag held by a pair of teabag grippers, the method including:

hooking, via a notch in a needle inserted through the teabag, a first mid-segment of a continuous portion of a thread adjacent to a first side of the teabag;

running said needle through the teabag along with the first mid-segment of the thread to a second side of the teabag opposite the first side and rotating the needle about its longitudinal axis to make an eye extending from the second side with the first mid-segment of the thread;

pushing, via a thread inserter, a second mid-segment of the continuous portion of the thread over an edge of the teabag from the first side to the second side, and inserting a loop of the second mid-segment through the eye formed by the first mid-segment to hang the loop of the second mid-segment on a hook of the teabag gripper at the second side of the teabag;

releasing the eye formed by the first mid-segment from the notch of the needle;

pulling, via a thread puller, a forward segment of the continuous portion of the thread before the first mid-segment so as to tighten the eye formed by the first mid-segment;

cutting the thread along an aft segment of the continuous portion of the thread after the second mid-segment; and

removing the teabag from the pair of teabag grippers in a manner so as to pull the second mid-segment through the hook of the teabag gripper such that a cut-end of the thread is correspondingly pulled through the eye formed by the first mid-segment before being pulled through the hook of the teabag gripper.

[00094] In Example 16, the subject matter of Example 15 may optionally include that rotating the needle about its longitudinal axis may include rotating the needle 450° +/- 5° about its longitudinal axis.

[00095] In Example 17, the subject matter of Example 15 or 16 may optionally include that the forward segment of the continuous portion of the thread may be clamped to the thread puller.

[00096] In Example 18, the subject matter of Example 17 may optionally include releasing the clamped forward segment of the continuous portion of the thread after the teabag is removed from the pair of teabag grippers.

[00097] In Example 19, the subject matter of any one of Examples 15 to 18 may optionally include clamping the aft segment of the continuous portion of the thread to the thread puller prior to cutting the thread.

[00098] In Example 20, the subject matter of Example 19 may optionally include that cutting the thread may include cutting the thread after the second mid-segment and before the clamped aft segment.

[00099] In Example 21, the subject matter of Example 21 may optionally include that releasing the eye from the notch of the needle may include pushing the eye off the notch of the needle via friction as the thread inserter moves through the eye.

[000100] Example 22 is a system for attaching a tag to a piece of thread from a teabag, the system including

a needle configured to be rotatable about its longitudinal axis and configured to be movable in its axial directions;

a threaded-teabag conveying module configured to convey the threaded-teabag to a tag attachment position with respect to the needle so as to attach the tag to the piece of thread on the teabag, the threaded-teabag conveying module may include at least one threaded-teabag receiving portion having a tag-receiving surface and a cavity in the tag-receiving surface,

wherein, when the at least one threaded-teabag receiving portion is in the tag attachment position, the cavity of the tag-receiving surface may be aligned with the needle in a manner such that axial movement of the needle may insert a tip of the needle into the cavity 516 of the tag-receiving surface; and

a tag pusher configured to be operable to engage with a tag on the tag-receiving surface to move the tag,

wherein, when the at least one threaded-teabag receiving portion is in the tag attachment position, the tag pusher may be aligned to the tag-receiving surface 514 of the at least one threaded-teabag receiving portion in a manner so as to be operable to engage and push the tag along the tag-receiving surface.

[000101] In Example 23, the subject matter of Example 22 may optionally include a thread-clip, wherein when the at least one threaded-teabag receiving portion is in the tag attachment portion, the thread-clip may be configured to hold a segment of the piece of thread against a portion of the at least one threaded-teabag receiving portion.

[000102] In Example 24, the subject matter of Example 22 or 23 may optionally include that the threaded-teabag conveying module may include a wheel with the at least one threaded-teabag receiving portion along a circumference of the wheel, wherein the wheel may be rotatble about a wheel rotational axis to thereby allow the at least one threaded-teabag receiving portion to be placed in diverse angular positions with one of said angular positions corresponding to the tag attachment position.

[000103] In Example 25, the subject matter of any one of Examples 22 to 25 may optionally include a needling module having the needle, and two sets of cam and lever mechanism coupled to the needle in a manner such that a first set of cam and lever mechanism may control a rotation of the needle about its longitudinal axis and a second set of cam and lever mechanism may control an axial movement of the needle.

[000104] Example 26 is a method of attaching a tag to a piece of thread of a teabag, the method including:

punching a needle through the tag from a first side to a second side;

hooking, via a notch in the needle, a first segment of the piece of thread adjacent to the second side;

running the needle through the tag along with the first segment of the piece of thread to the first side;

rotating the needle to twist the first segment of the piece of thread in a manner so as to form an eye;

moving the tag such that the tag is below the needle;

hooking, via the notch in the needle, a second segment of the piece of thread; and

running the needle through the eye formed by the first segment along with the second segment until an end of the piece of thread correspondingly followed through the eye formed by the first segment.

[000105] In Example 27, the subject matter of Example 26 may optionally include that rotating the needle may include rotating the needle 450° +/- 5° about its longitudinal axis.

[000106] Example 28 is a system for attaching a tag to a piece of thread from a teabag, the system including

a heat-seal-tagging arrangement; and

a threaded-teabag conveying module configured to convey the teabag, which has the piece of thread attached to the teabag2, to a tag attachment position with respect to the heat-seal-tagging arrangement so as to attach the tag to the piece of thread 704 of the teabag,

wherein heat-seal-tagging arrangement may include

a thread puller configured to pull a leading segment of the piece of thread from the teabag over an edge of the tag,

a thread guide configured to fold the leading segment of the piece of thread in a manner so as to place the leading segment of the piece of thread over an adhesive portion of the tag,

a pair of jaws configured to clamp the folded piece of thread and the tag therebetween, and

a heating element coupled to one or both the jaws in a manner so as to heat the adhesive portion of the tag to bind the piece of thread to the tag.

[000107] In Example 29, the subject matter of Example 28 may optionally include that the thread puller and the thread thread guide may be arranged in a manner in which respective motions are in directions in a range of 90° +/-10° relative to each other.

[000108] Example 30 is a method of attaching a tag to the piece of thread of the threaded-teabag, the method including:

pulling, via the thread puller, a leading segment of the piece of thread over an edge of the tag;

folding, via the thread guide, the leading segment of the piece of thread to place the leading segment of the piece of thread over an adhesive portion of the tag on the second side of the tag;

clamping, via a pair of jaws, the leading segment of the piece of thread to the tag; and

applying a heat, via a heating element, so as to bind the piece of thread to the adhesive portion of the tag.

[000109] Various embodiments have provided a cheaper and less wasteful solution for the teabag manufacturers to convert their existing teabag bagging machine to produce teabag without staples. Various embodiments have allowed the stapling modules of existing teabag bagging machine to be modified in into a system for tying a thread to the teabag and/or the tag.

[000110] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes, modification, variation in form and detail may be made therein without departing from the scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

Claims

1. A thread tying module configured to be mounted to a teabag bagging machine, the module comprising:

a rotation shaft configured to be coupled to a driving mechanism;

two or more cams fixedly joined to the rotation shaft such that the two or more cams rotate together with the rotation shaft;

two or more levers, each lever having a first connection portion in engagement with a corresponding cam of said cams, and having a pivot axis parallel to a rotational axis of the rotation shaft;

two or more linkage mechanisms, each linkage mechanism connected to a respective second connection portion of a corresponding lever of said levers;

a needle assembly comprising a needle and a needle holder, the needle configured to be rotatable about its longitudinal axis with respect to the needle holder, the needle holder being connected to a first linkage mechanism of the linkage mechanisms, configured to impart a translation motion to the needle assembly in a plane perpendicular to the rotational axis of the rotation shaft so as to move the needle assembly between a forward disposition, an intermediate disposition and a retracted disposition;

a thread pusher assembly comprising a thread pusher head and a thread inserter which is formed as an angular piece having a first inserter arm which is pivotably mounted to the thread pusher head with a pivot axis parallel to the rotational axis of the rotation shaft, and having a second inserter arm which is arc-shaped and extends in an angle relative to the first inserter arm, wherein the thread pusher head is connected to a second linkage mechanism of the linkage mechanisms, configured to impart a translation motion to the thread pusher assembly in the plane perpendicular to the rotational axis of the rotation shaft so as to move the thread pusher assembly between a forward disposition and a retracted disposition,

wherein the needle assembly and the thread pusher assembly are arranged in a manner such that, when both the assemblies are in the respective forward disposition, the thread pusher head of the thread pusher assembly engages and pushes a thread towards the needle assembly, and the needle assembly engages with the thread on the thread pusher head of the thread pusher assembly.

2. The module as claimed in claim 1, wherein the needle assembly and the thread pusher assembly are arranged in a manner in which translation motions thereof are in directions in a range of 90° +/-10° relative to each other.

3. The module as claimed in claim 1 or 2, wherein the first linkage mechanism is a planar linkage mechanism, and wherein the first linkage mechanism comprises

a first link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a first rocker-arm-link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the first link rod,

a first coupler link with a first connection portion connected to a second connection portion of the first rocker-arm-link, and

a first follower link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the first coupler link,

wherein the needle holder is connected to the first coupler link with the needle arranged with its longitudinal axis extending parallel to a longitudinal extension of the first coupler link.

4. The module as claimed in any one of claims 1 to 3, wherein the second linkage mechanism is a planar linkage mechanism, and wherein the second linkage mechanism comprises

a second link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a second rocker-arm-link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the second link rod,

a second coupler link with a first connection portion connected to a second connection portion of the second rocker-arm-link, and

a second follower link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the second coupler link,

wherein the thread pusher head is connected to the second coupler link.

5. The module as claimed in claim 4 in combination with claim 3, wherein the first coupler link and the second coupler link longitudinally extend in directions in a range of 90° +/-10° relative to each other.

6. The module as claimed in any one of claims 1 to 5, wherein the two or more cams comprise four cams, wherein the two or more levers comprise four levers, and wherein the two or more linkage mechanisms comprise four linkage mechanisms.

7. The module as claimed in claim 6, wherein the needle of the needle assembly is connected to a third linkage mechanism of the linkage mechanisms, configured to convert a lever motion of the corresponding lever into a corresponding rotation of the needle about its longitudinal axis.

8. The module as claimed in claim 7, wherein the third linkage mechanism is a spatial linkage mechanism, and wherein the third linkage mechanism comprises

a third link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a third rocker-arm-link which has a pivot axis lying in another plane perpendicular to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the third link rod,

a third coupler link with a first connection portion connected to a second connection portion of the third rocker-arm-link, and

a quadrant gear with a pivot shaft parallel to the pivot axis of the third rocker-arm-link and with a connection portion of the pivot shaft connected to a second connection portion of the third coupler link,

wherein the needle comprises a gear in engagement with the quadrant gear.

9. The module as claimed in any one of claims 6 to 8, wherein the thread inserter of the thread pusher assembly is connected to a fourth linkage mechanism of the linkage mechanisms, configured to impart a rotation to the thread inserter between a forward disposition, in which the second inserter arm engages the thread for pushing the same, and a retracted disposition, in which the second inserter arm is disengaged from the thread.

10. The module as claimed in claim 9, wherein the fourth linkage mechanism is a planar linkage mechanism, and wherein the fourth linkage mechanism comprises

a fourth link rod with a first connection portion connected to the second connection portion of the corresponding lever,

a fourth rocker-arm-link which has a pivot axis parallel to the rotational axis of the rotation shaft and which has a first connection portion connected to a second connection portion of the fourth link rod, and

a fourth coupler link with a first connection portion connected to a second connection portion of the fourth rocker-arm-link and a second connection portion connected to the thread inserter in a manner so as to convert a linear motion of the fourth coupler link to a rotation motion of the thread inserter..

11. The module as claimed in any one of claims 1 to 10, further comprising a thread puller assembly which, when seen in a direction of the rotational axis of the rotation shaft, is arranged on an opposite side of the needle assembly with respect to the thread pusher assembly, and is optionally arranged adjacent to the thread pusher assembly, wherein the

thread puller assembly comprises a tensioning spool rotatable about a spool shaft parallel to the rotational axis of the rotation shaft, by which the tensioning spool is operable to apply a pulling force to the thread which extends from a reservoir spool to between the needle assembly and the thread pusher assembly, to the tensioning spool.

12. A system for attaching a piece of thread to a teabag, the system comprising:

the thread tying module of anyone of claims 1 to 11; and

a teabag conveying module configured to convey the teabag to a knotting position with respect to the thread tying module so as to attach the piece of thread to the teabag,

wherein the teabag conveying module comprises at least one teabag receiving portion having a hook,

wherein, when said teabag receiving portion of the teabag conveying module is in the knotting position and the thread pusher assembly of the thread tying module is in the forward disposition, the hook of the teabag receiving portion is disposed with respect to the second inserter arm of the thread inserter of the thread pusher assembly in a manner such that a direction of movement of the second inserter arm of the thread inserter is toward the hook.

13. The system as claimed in claim 12, wherein the teabag conveying module comprises a wheel with said teabag receiving portion along a circumference of the wheel, the wheel being rotatable about a wheel rotational axis, which extends in parallel to the rotational shaft, to thereby allow the teabag receiving portion to be placed in diverse angular positions with one of said angular positions corresponding to the knotting position of the teabag.

14. The system as claimed in claim 12 or 13, wherein said teabag receiving portion comprises a pair of grippers, wherein the hook is on one of the pair of grippers.

15. A method of attaching a piece of thread to a teabag held by a pair of teabag grippers, the method comprising:

hooking, via a notch in a needle inserted through the teabag, a first mid-segment of a continuous portion of a thread adjacent to a first side of the teabag;

running said needle through the teabag along with the first mid-segment of the thread to a second side of the teabag opposite the first side and rotating the needle about its longitudinal axis to make an eye extending from the second side with the first mid-segment of the thread;

pushing, via a thread inserter, a second mid-segment of the continuous portion of the thread over an edge of the teabag from the first side to the second side, and inserting a loop of the second mid-segment through the eye formed by the first mid-segment to hang the loop of the second mid-segment on a hook of the teabag gripper at the second side of the teabag;

releasing the eye formed by the first mid-segment from the notch of the needle;

pulling, via a thread puller, a forward segment of the continuous portion of the thread before the first mid-segment so as to tighten the eye formed by the first mid-segment;

cutting the thread along an aft segment of the continuous portion of the thread after the second mid-segment; and

removing the teabag from the pair of teabag grippers in a manner so as to pull the second mid-segment through the hook of the teabag gripper such that a cut-end of the thread is correspondingly pulled through the eye formed by the first mid-segment before being pulled through the hook of the teabag gripper.

16. The method as claimed in claim 15, wherein rotating the needle about its longitudinal axis comprises rotating the needle 450° +/- 5° about its longitudinal axis.

17. The method as claimed in claim 15 or 16, wherein the forward segment of the continuous portion of the thread is clamped to the thread puller.

18. The method as claimed in claim 17, further comprising releasing the clamped forward segment of the continuous portion of the thread after the teabag is removed from the pair of teabag grippers.

19. The method as claimed in any one of claims 15 to 18, further comprising clamping the aft segment of the continuous portion of the thread to the thread puller prior to cutting the thread.

20. The method as claimed in claim 19, wherein cutting the thread comprises cutting the thread after the second mid-segment and before the clamped aft segment.

21. The method as claimed in any one of claims 15 to 20, wherein releasing the eye from the notch of the needle comprises pushing the eye off the notch of the needle via friction as the thread inserter moves through the eye.

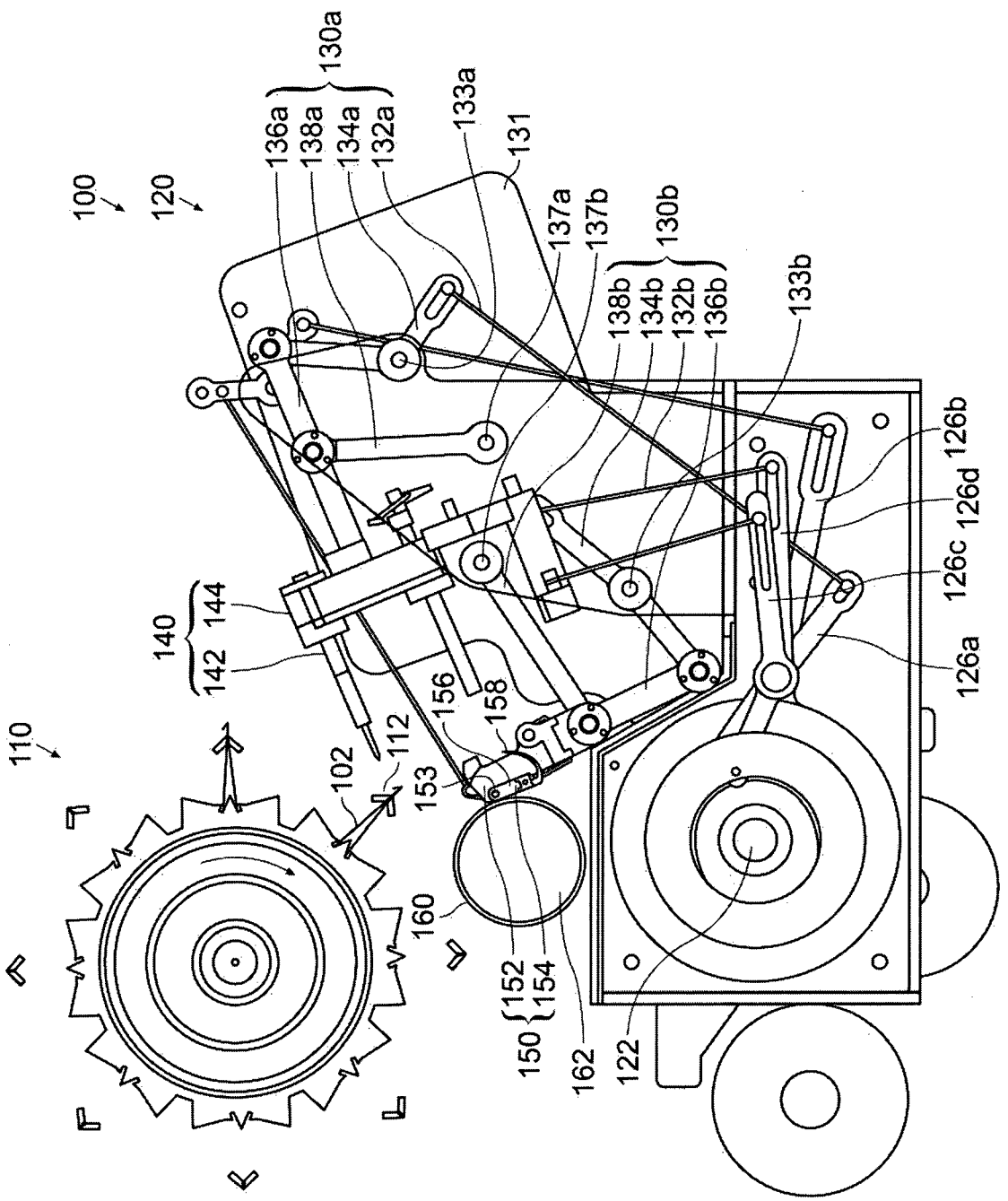
100
120
110
130a
136a
138a
134a
132a
133a
131
137a
137b
130b
138b
134b
132b
136b
133b
126b
126d
126c
126a
140
144
142
156
158
112
102
153
160
152
154
150
162
122
F
L
R

FIG. 1

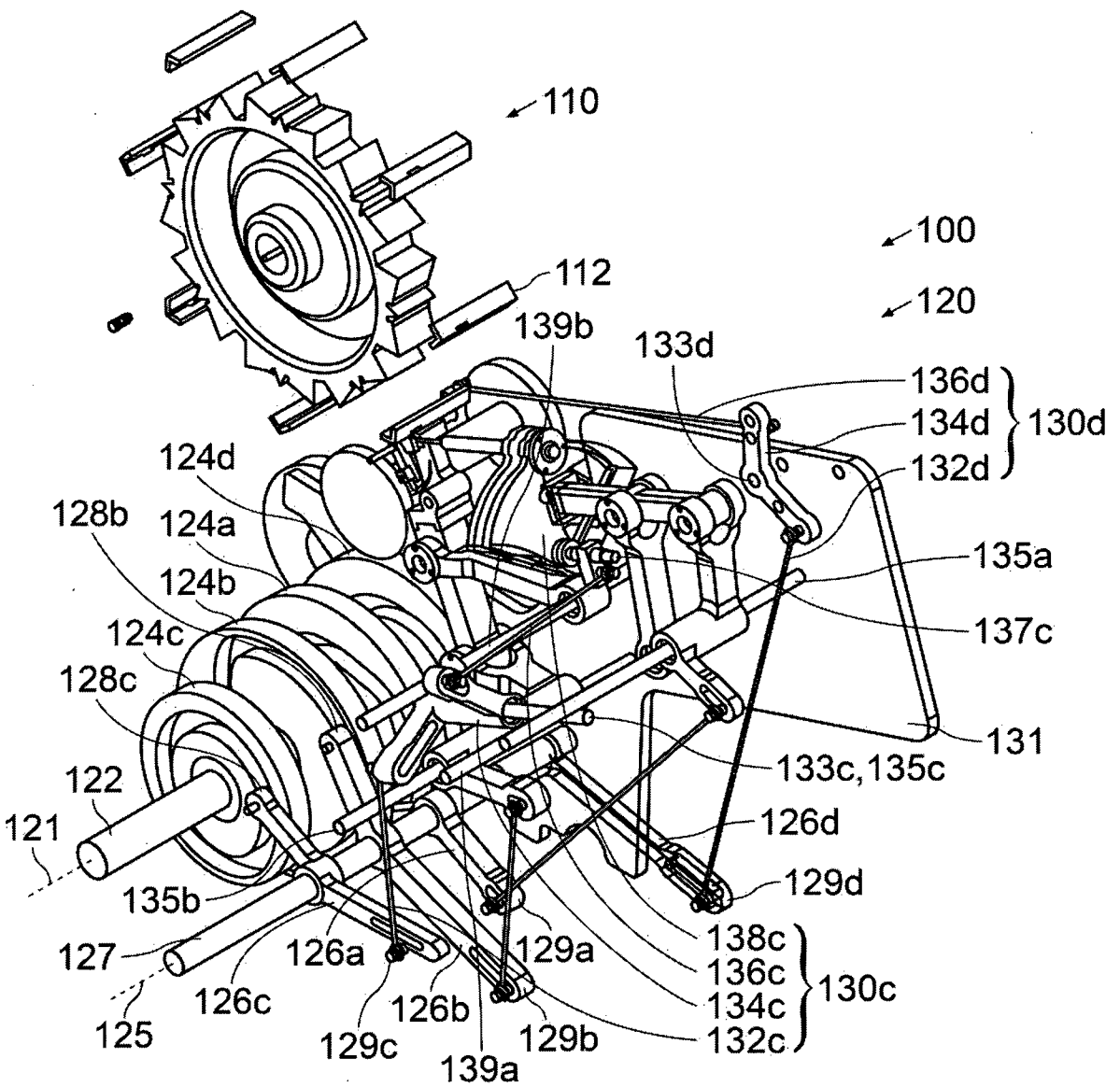
110
100
112
120
139b
133d
136d
134d
130d
132d
124d
128b
124a
135a
124b
137c
124c
128c
131
133c,135c
122
121
126d
129d
135b
138c
127
126a
129a
136c
126c
134c
130c
126b
125
129c
129b
132c
139a

FIG. 2

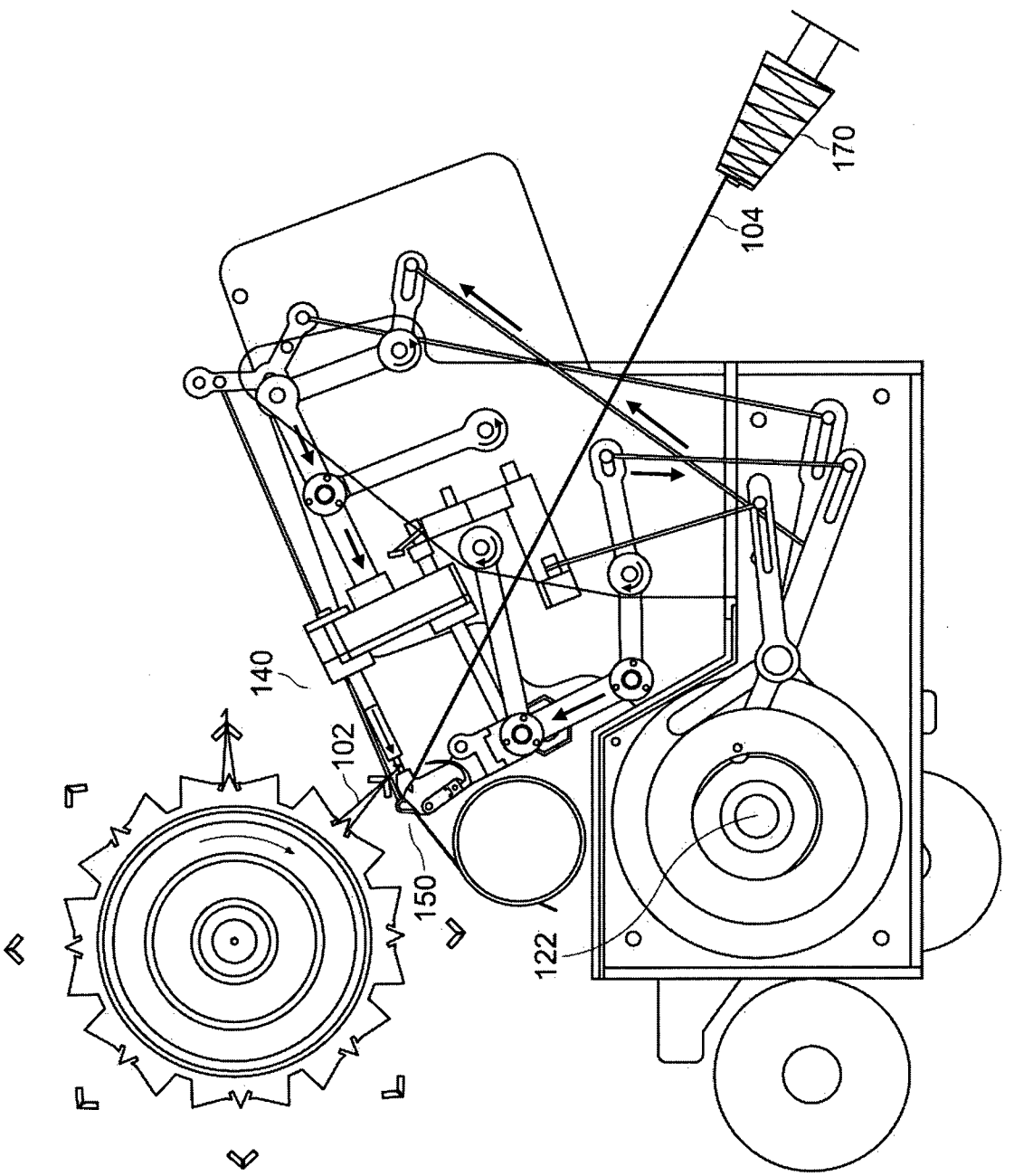

FIG. 3A

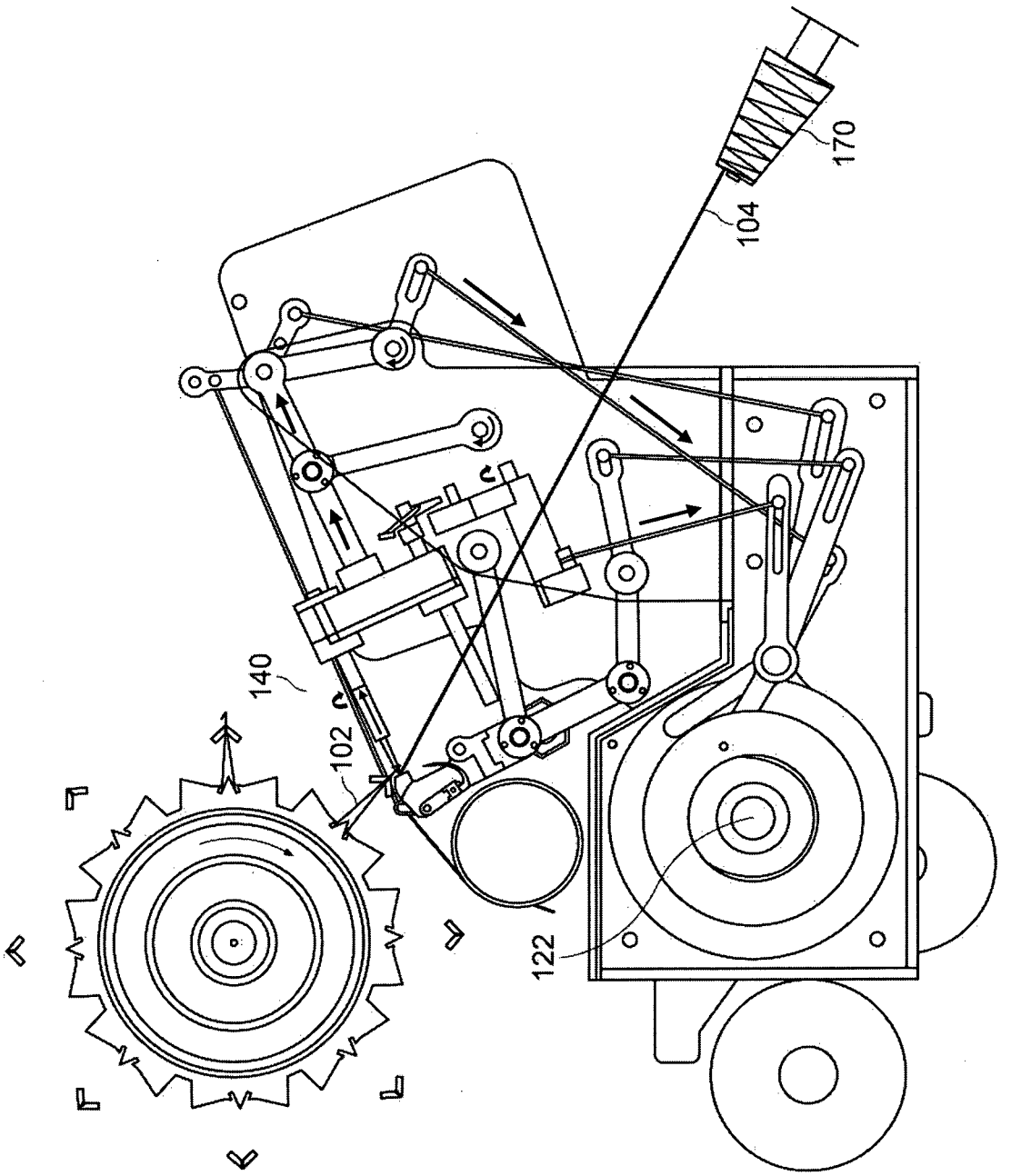

FIG. 3B

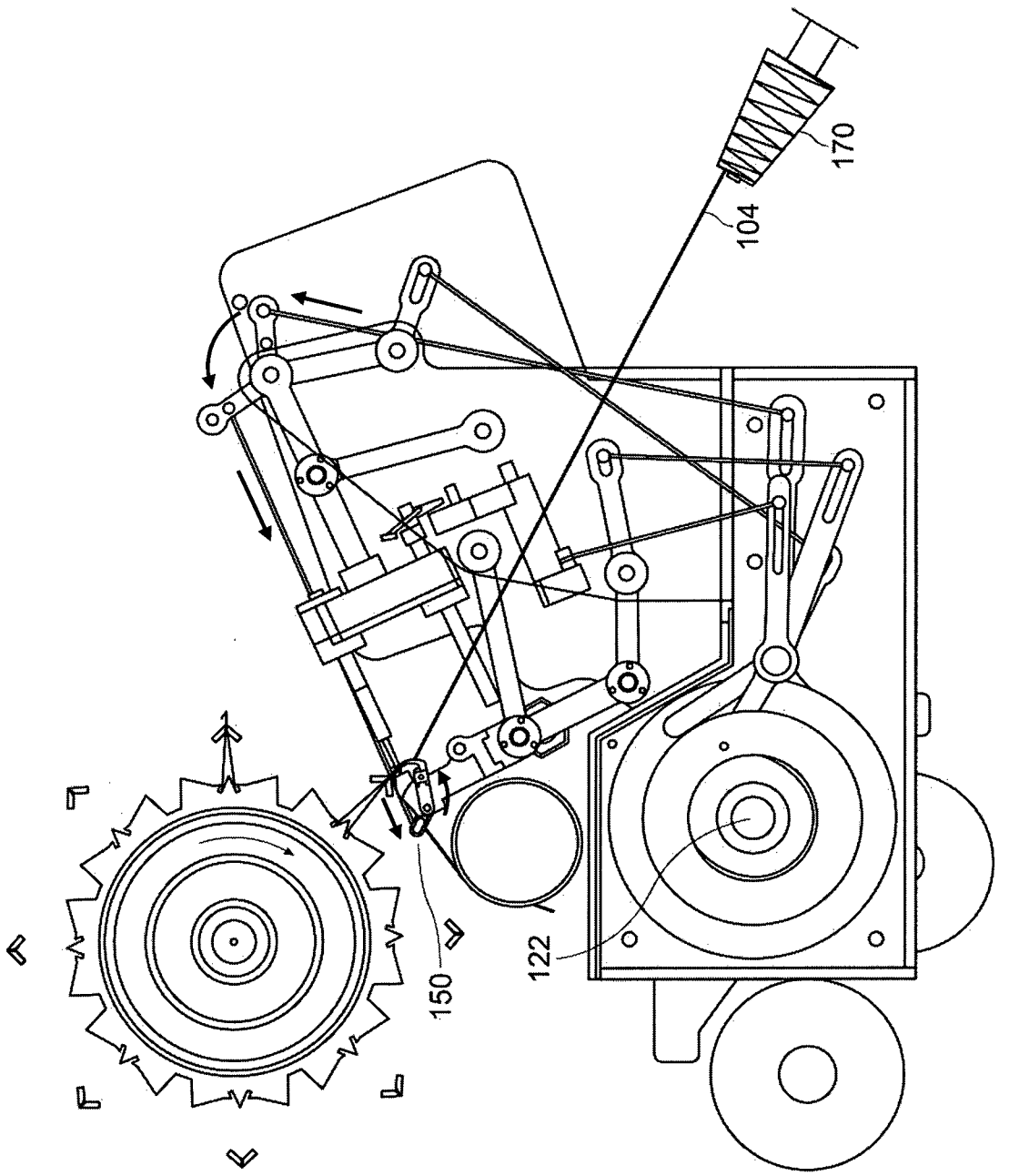

FIG. 3C

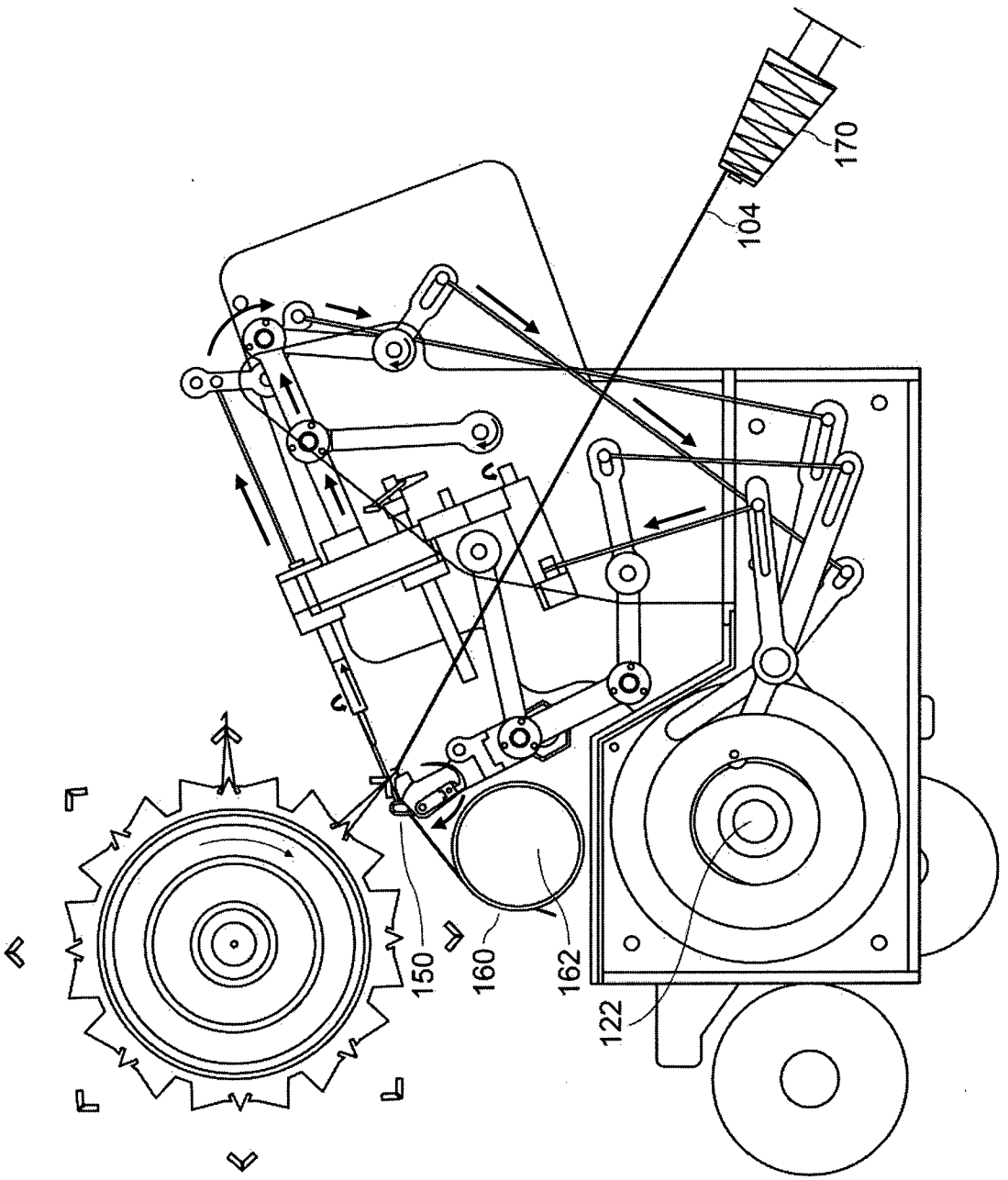

FIG. 3D

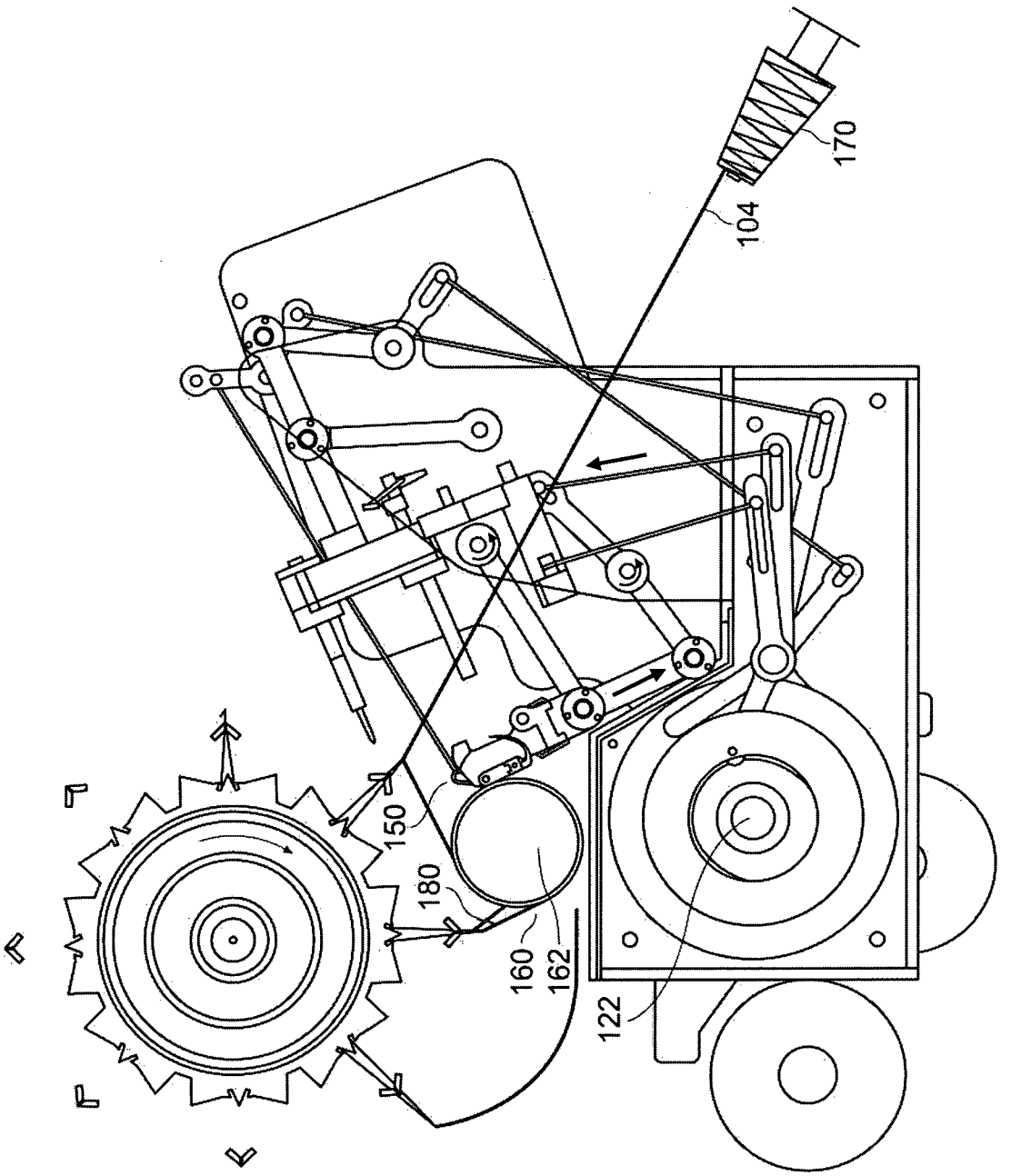

FIG. 3E

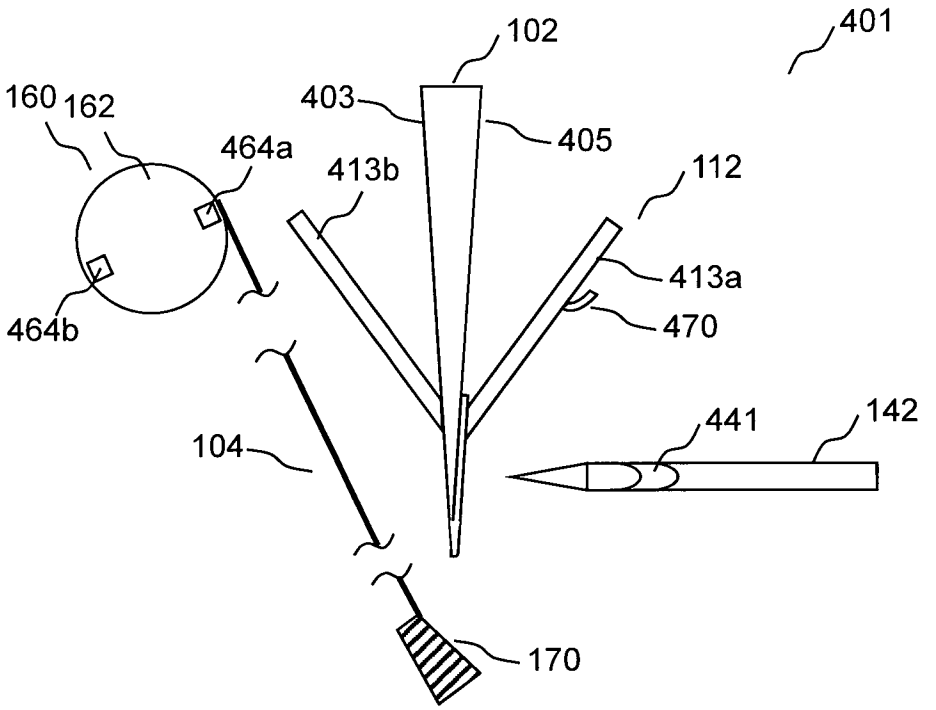
401
102
160
162
403
405
464a
413b
112
413a
464b
470
104
441
142
170

FIG. 4A

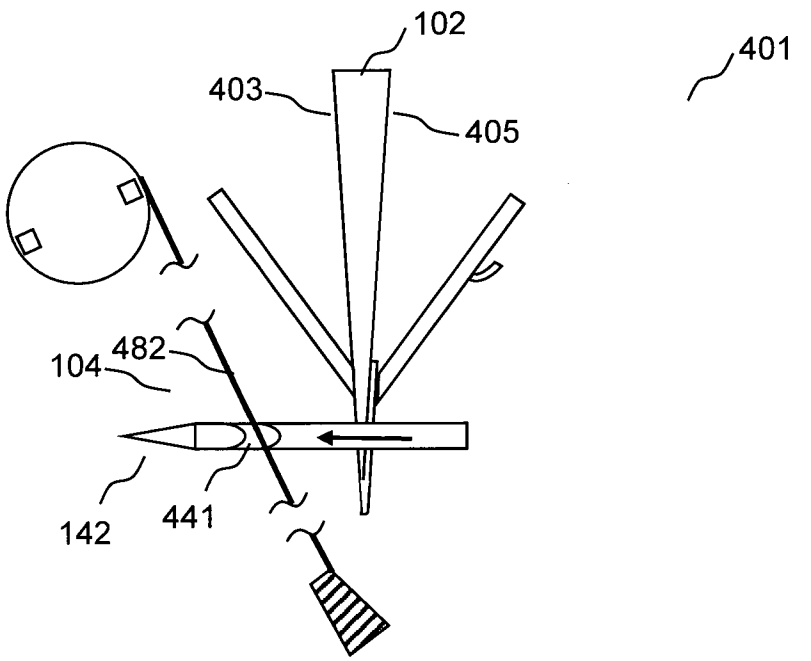
102
401
403
405
104
482
142
441

FIG. 4B

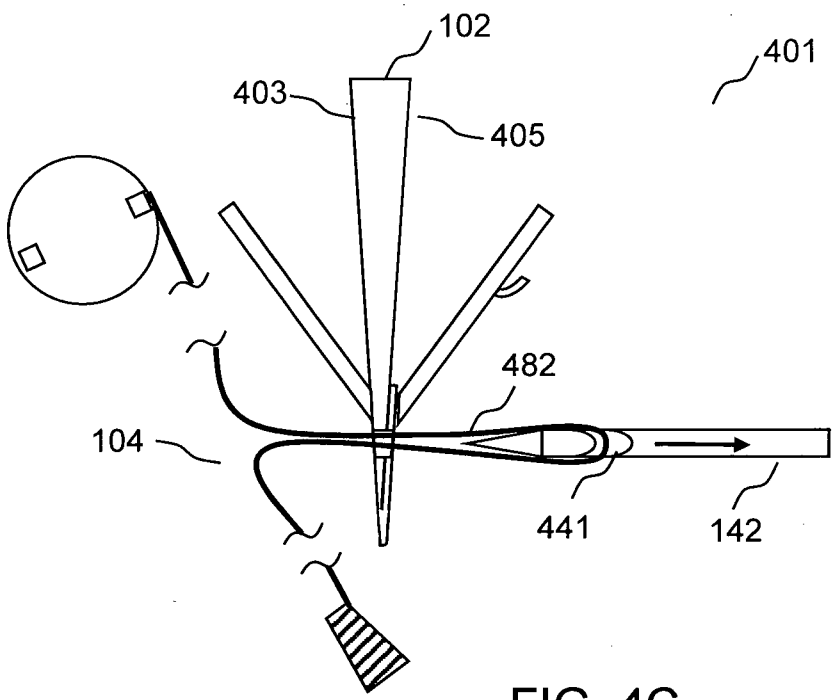
102
401
403
405
482
104
441
142

FIG. 4C

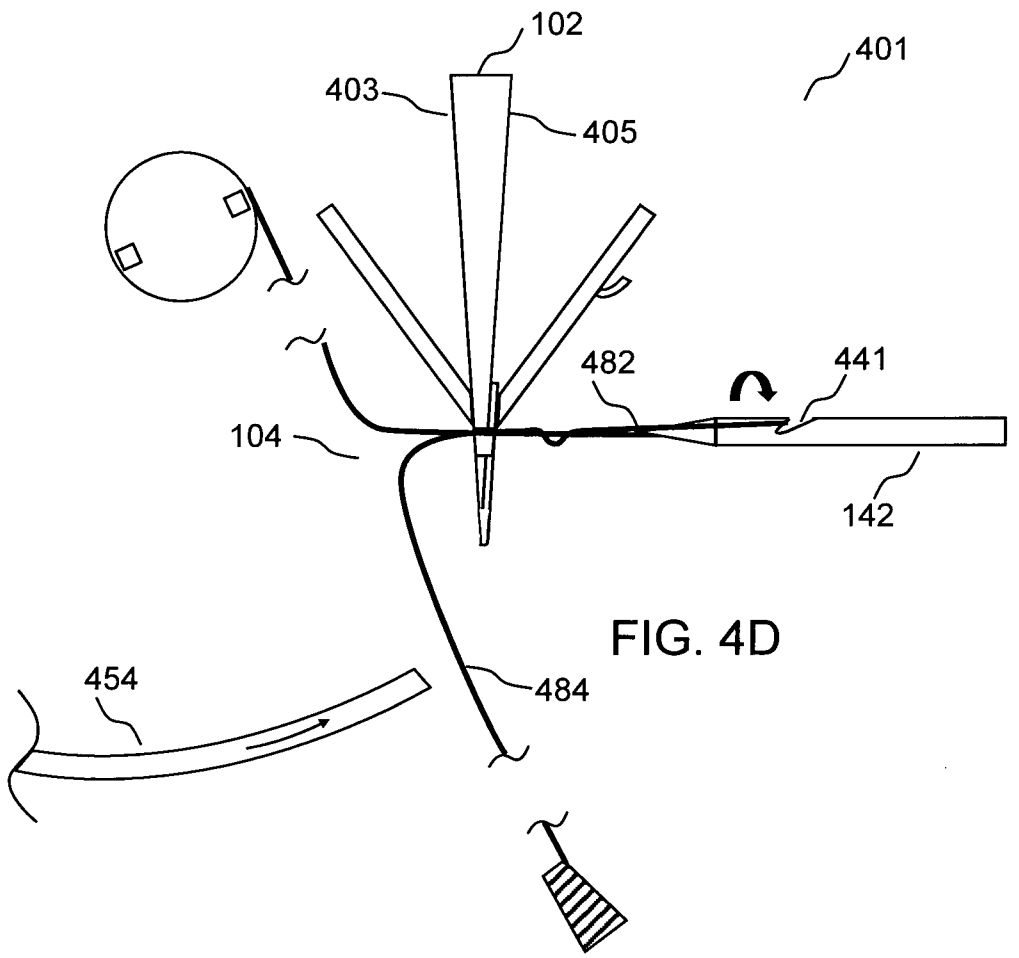
102
401
403
405
482
441
104
142
454
484

FIG. 4D

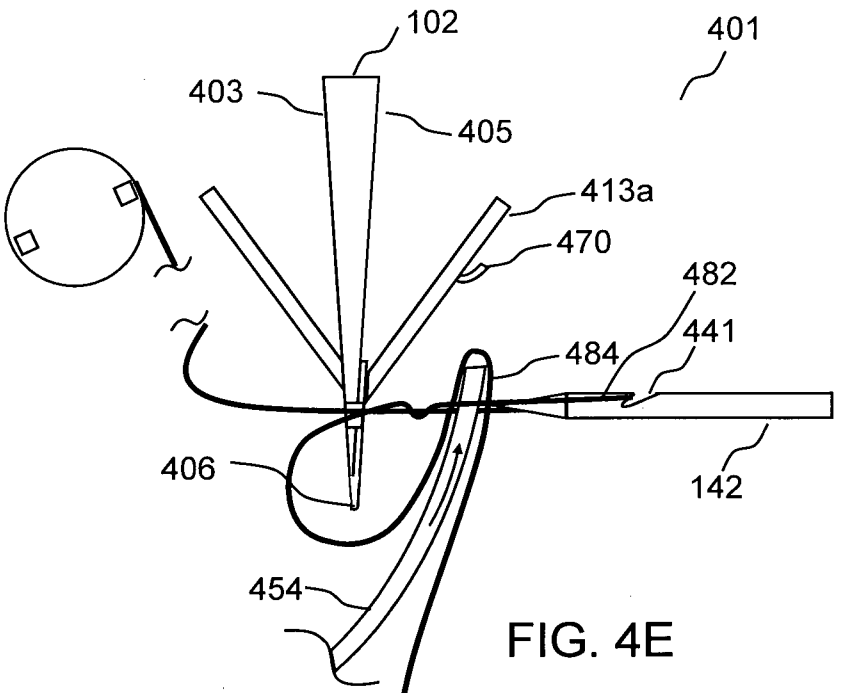
102
401
403
405
413a
470
482
484
441
406
142
454

FIG. 4E

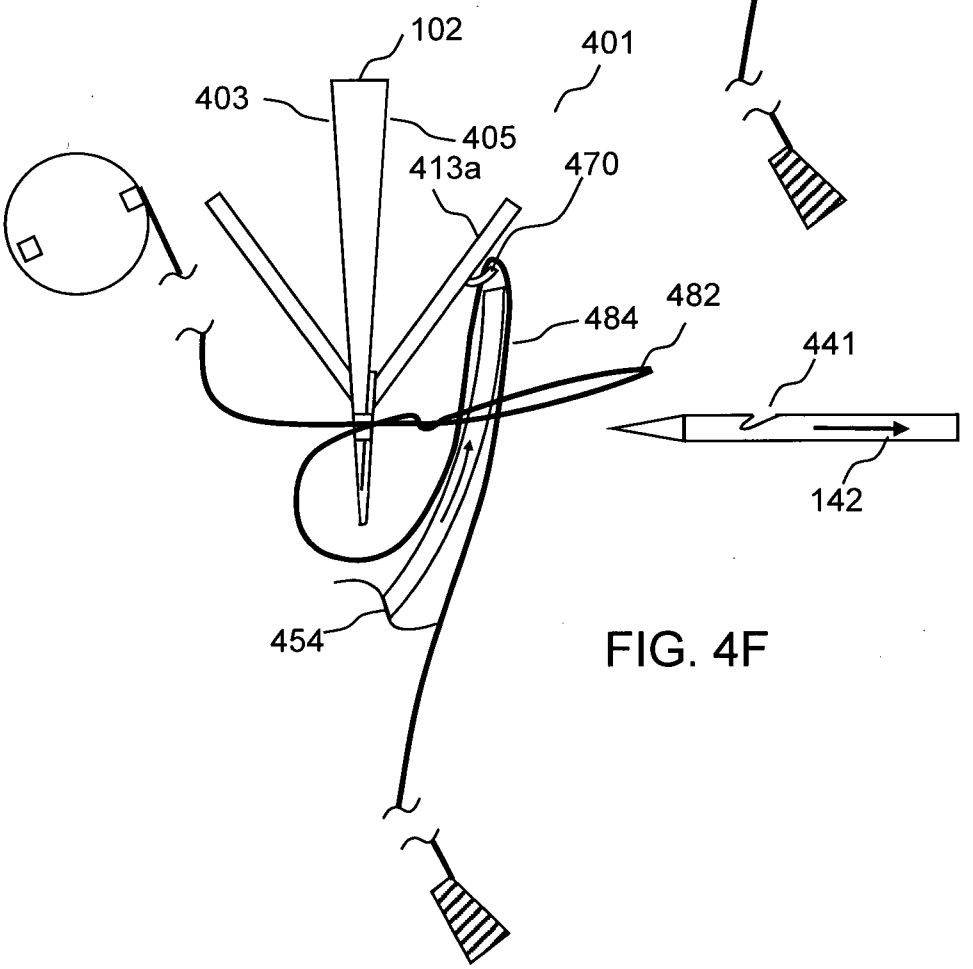
102
401
403
405
413a
470
484
482
441
142
454

FIG. 4F

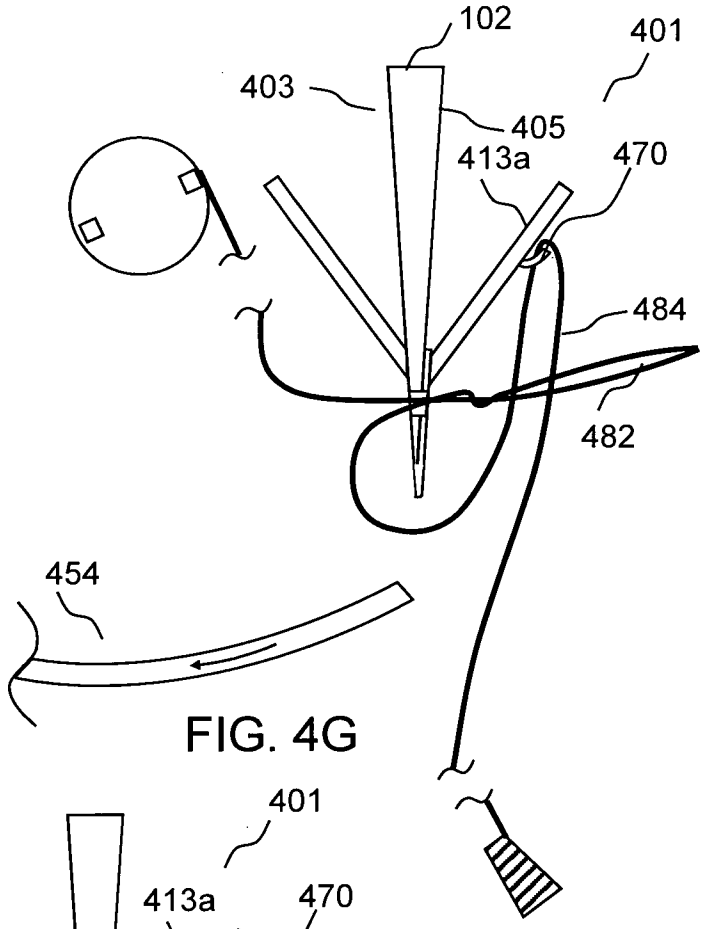
102
401
403
405
413a
470
484
482
454

FIG. 4G

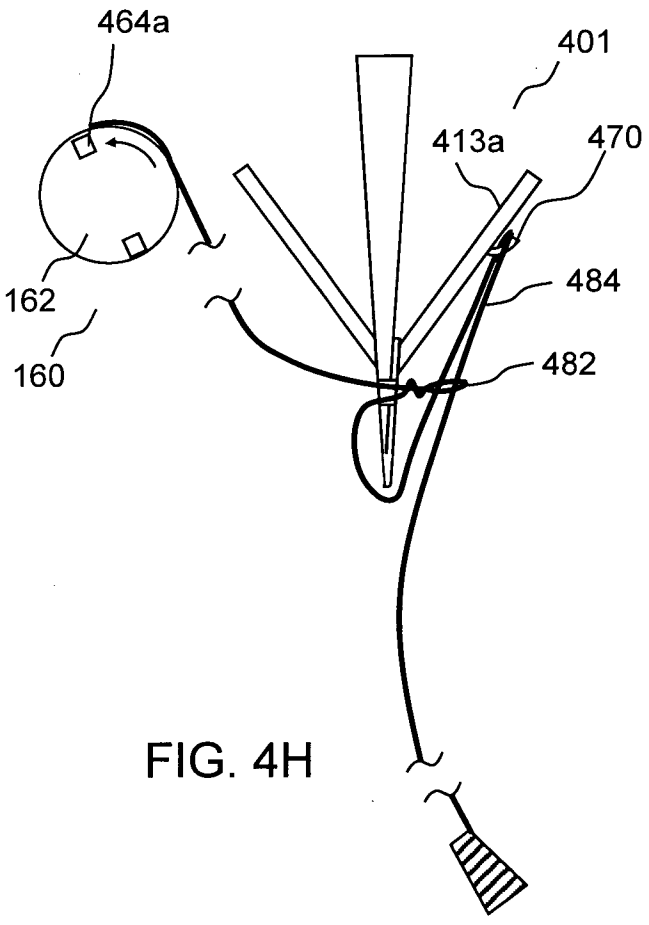
464a
401
413a
470
484
482
162
160

FIG. 4H

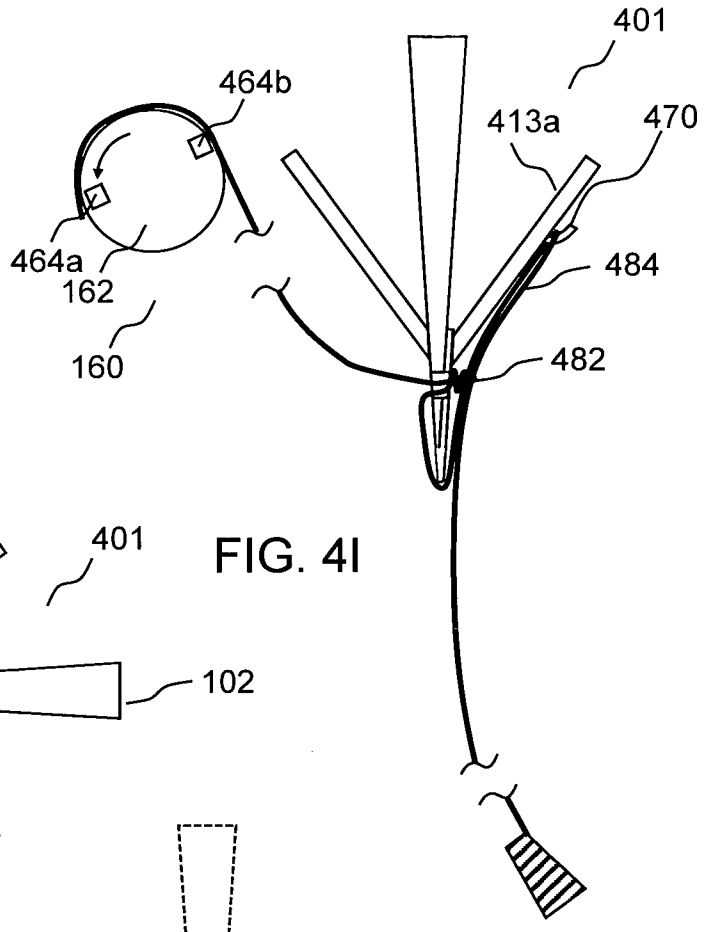
401
464b
413a
470
464a
162
484
160
482

FIG. 4I

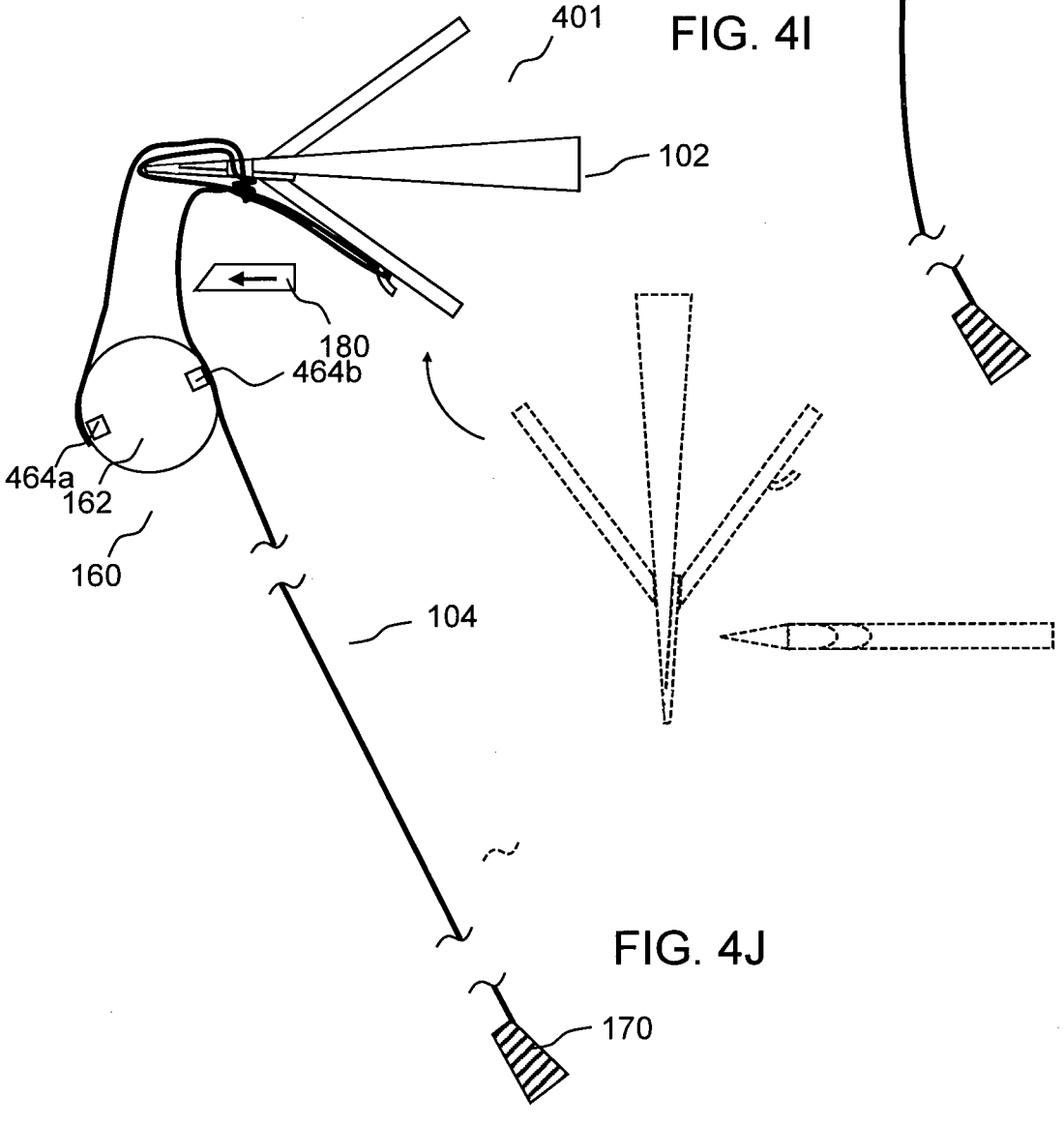
401
102
180
464b
464a
162
160
104
170

FIG. 4J

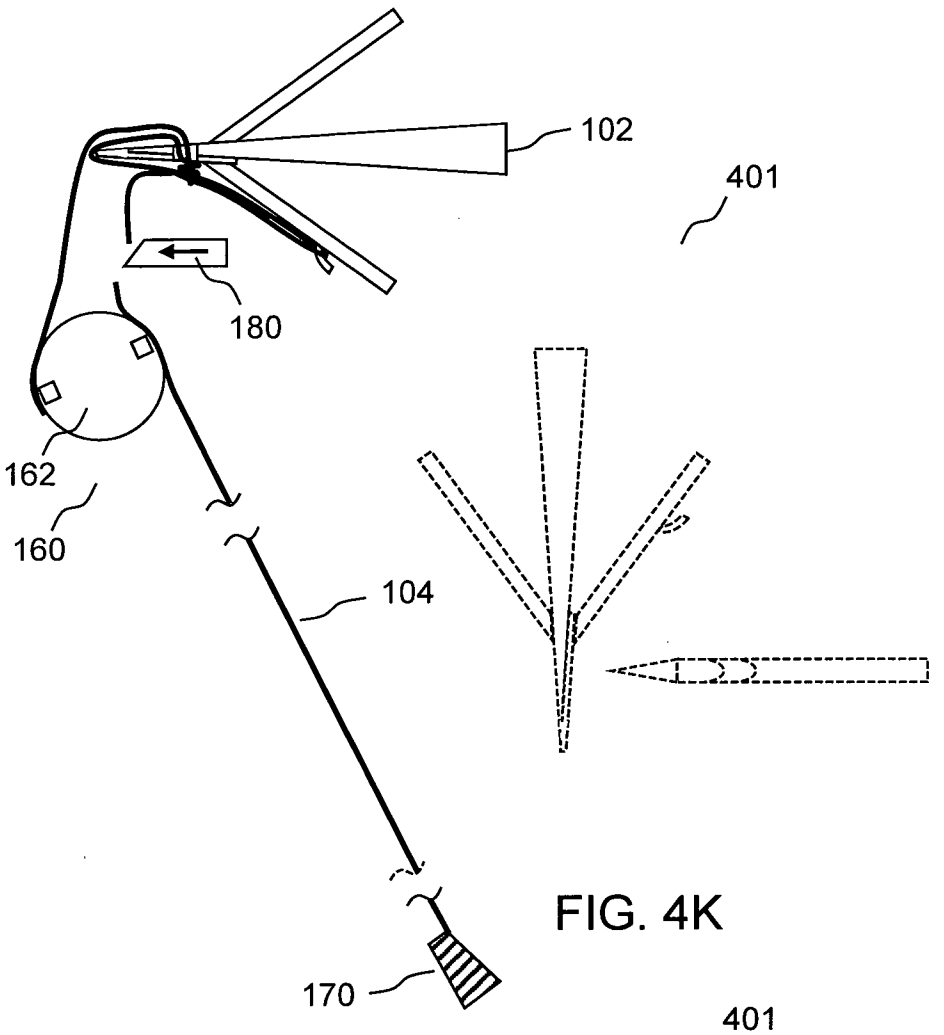
102
401
180
162
160
104
170

FIG. 4K

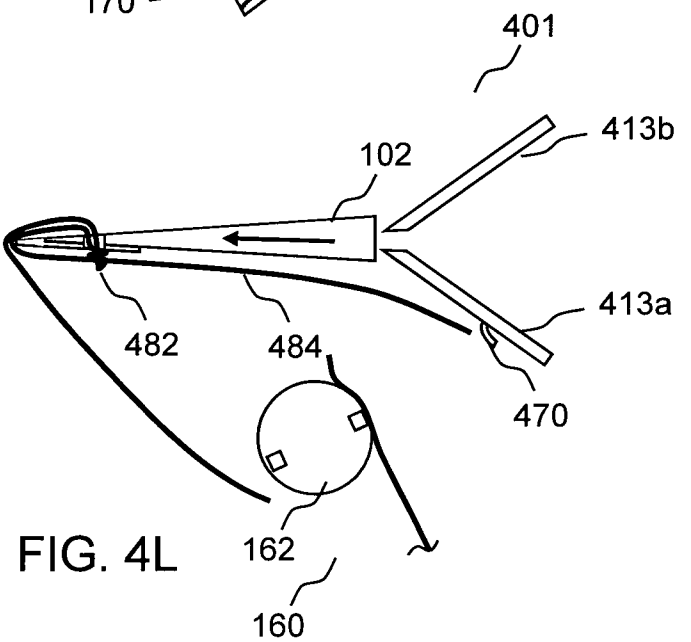
401
413b
102
413a
482
484
470
162
160

FIG. 4L

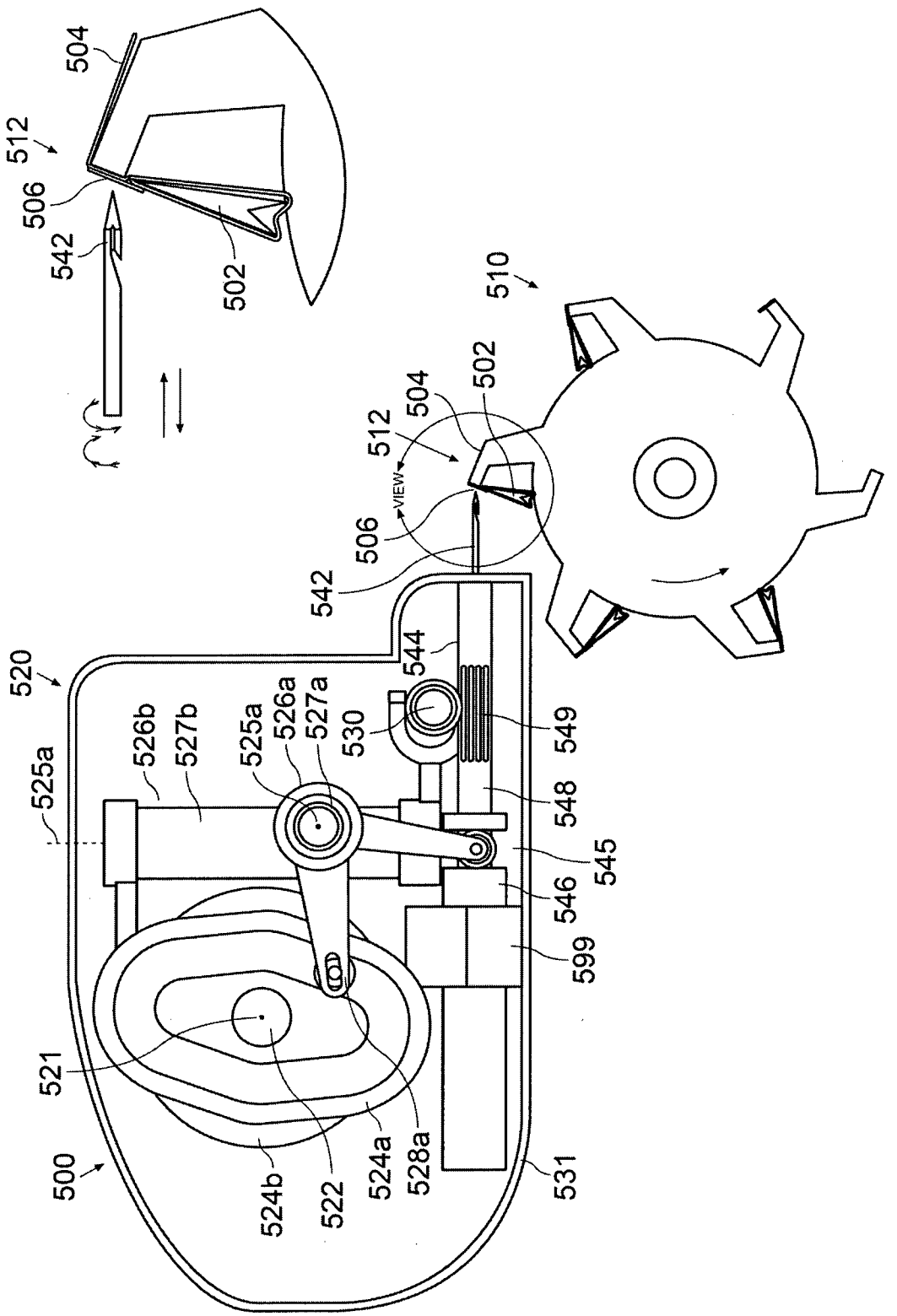
504
512
506
542
502
510
VIEW
520
525a
526b
527b
525a
526a
527a
530
544
549
548
545
546
599
521
500
524b
522
524a
528a
531

FIG. 5A

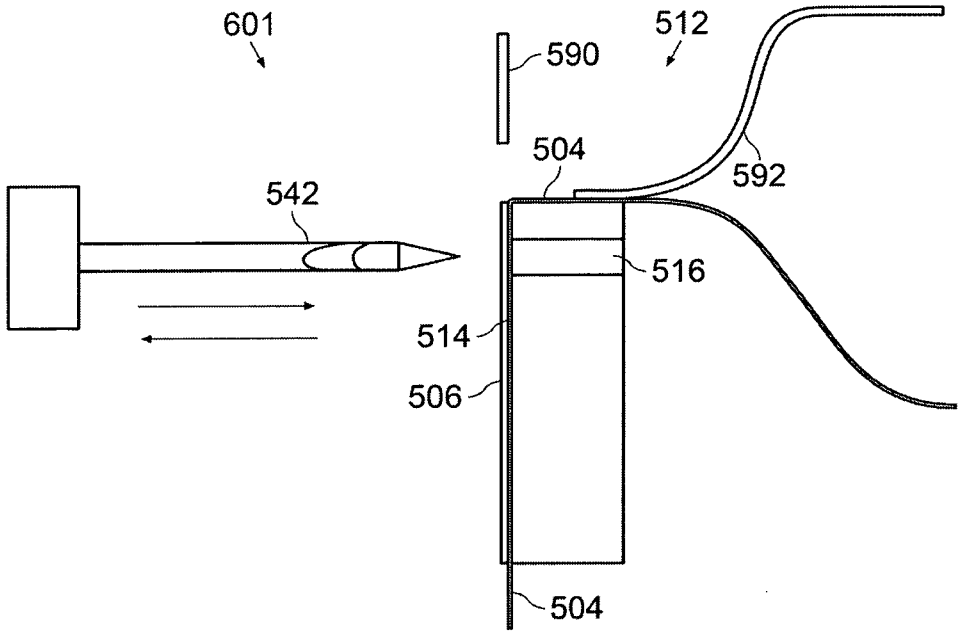
601
590
512
504
592
542
516
514
506
504

FIG. 6A

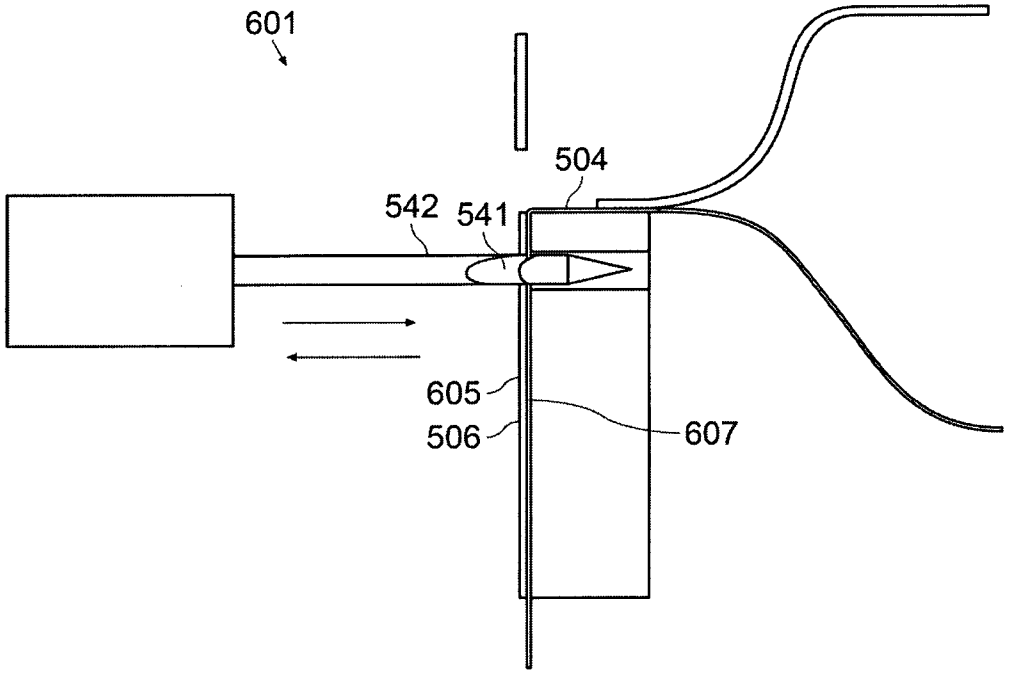
601
504
542
541
605
506
607

FIG. 6B

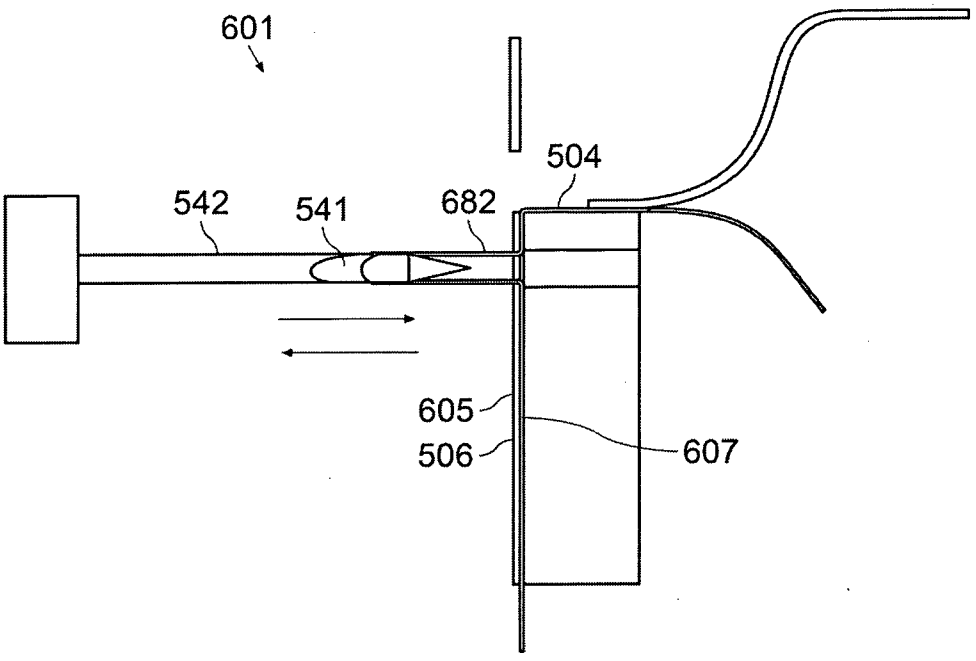

FIG. 6C

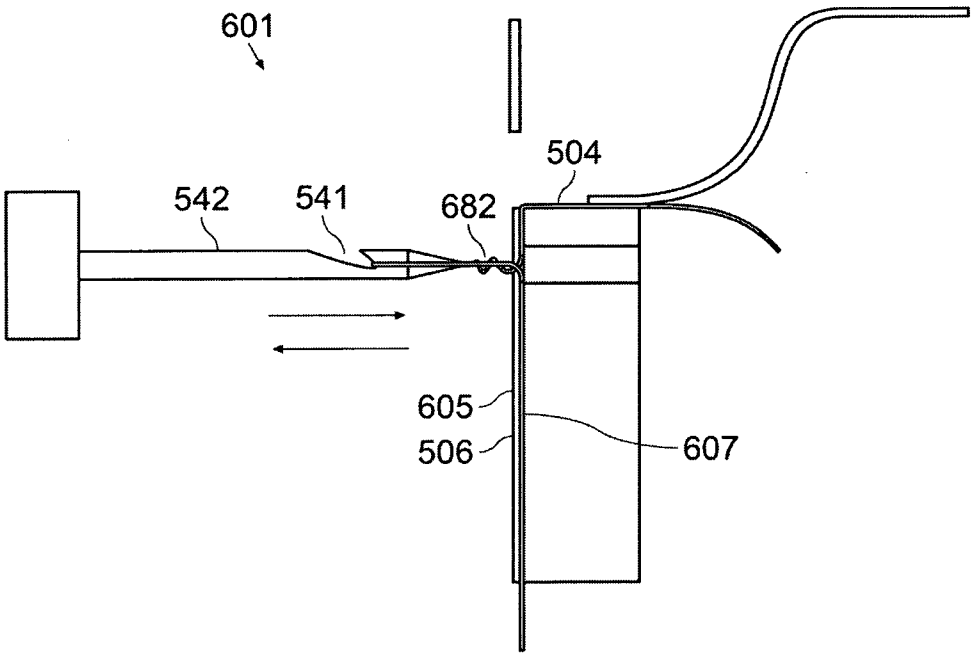

FIG. 6D

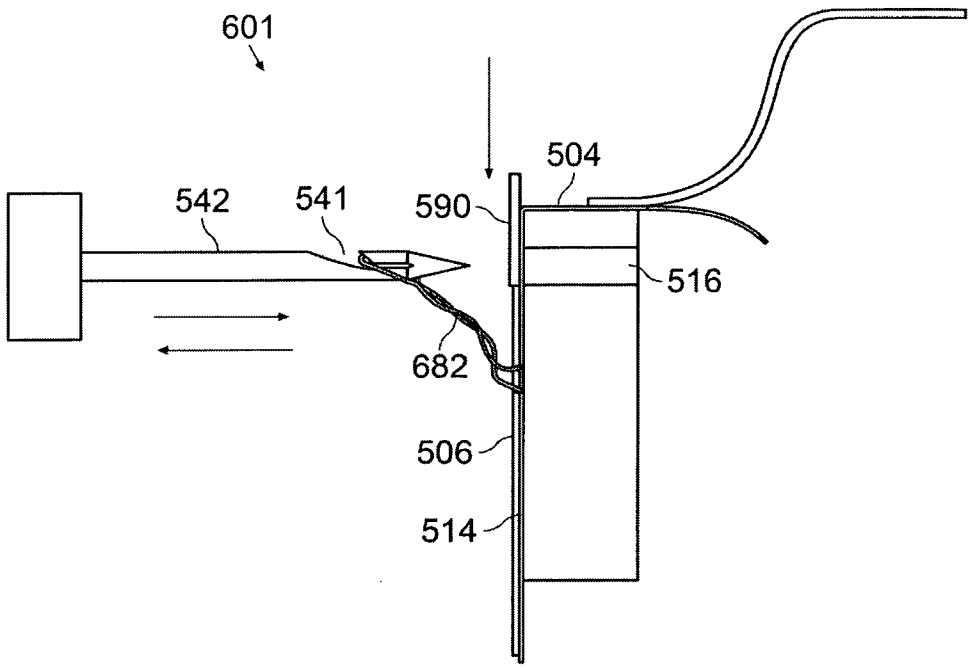
601
504
542
541
590
516
682
506
514

FIG. 6E

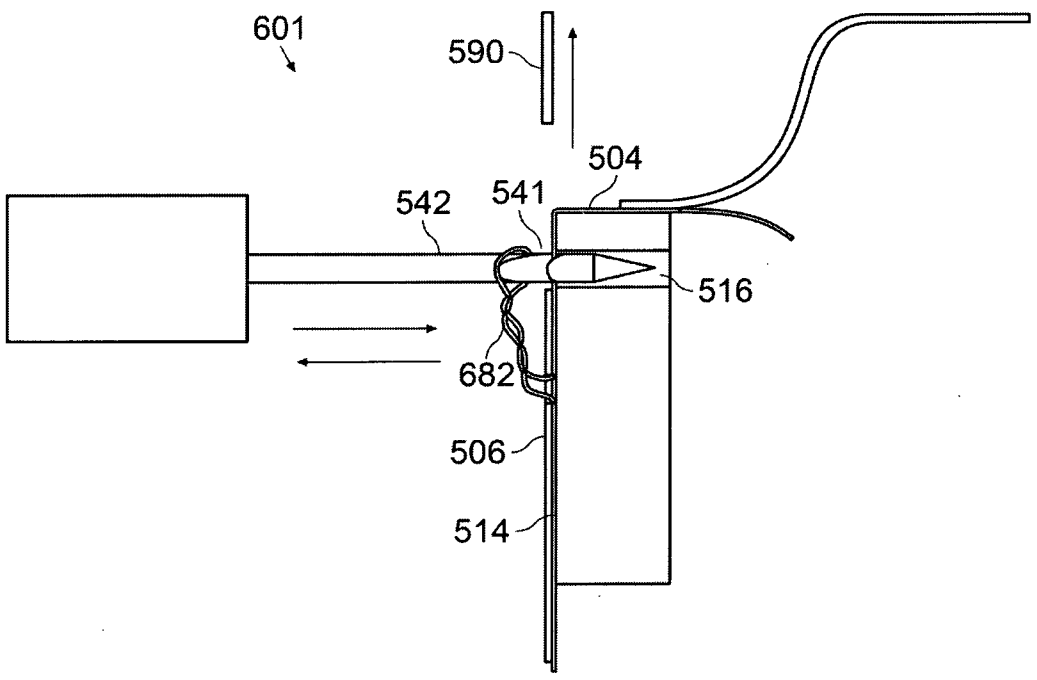
601
590
504
542
541
516
682
506
514

FIG. 6F

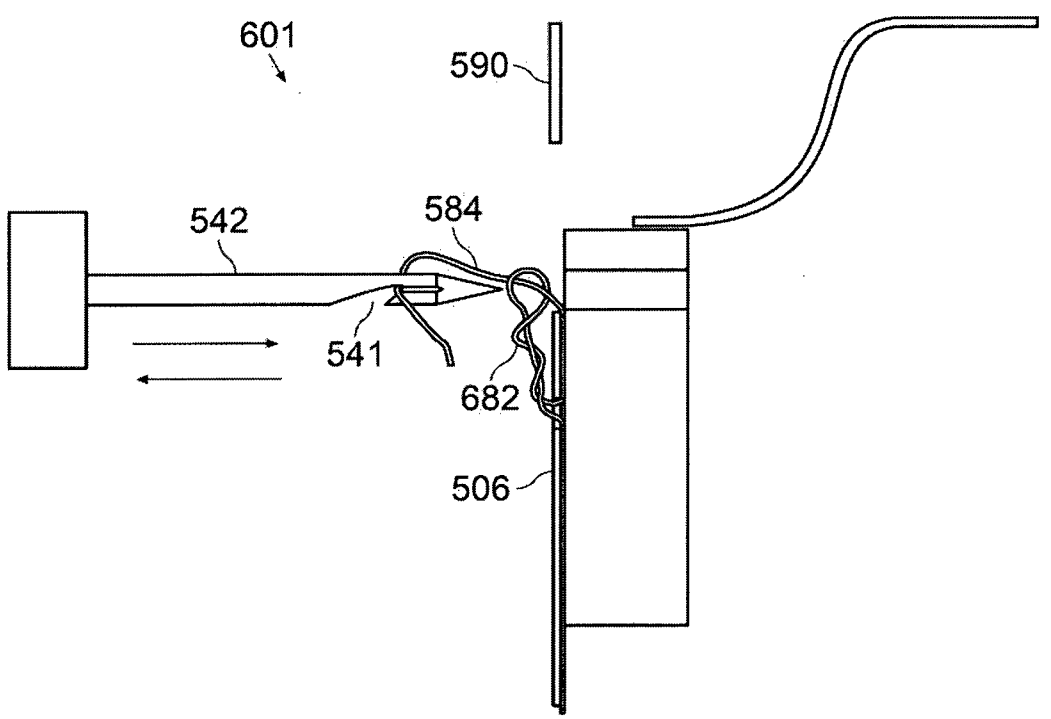

FIG. 6G

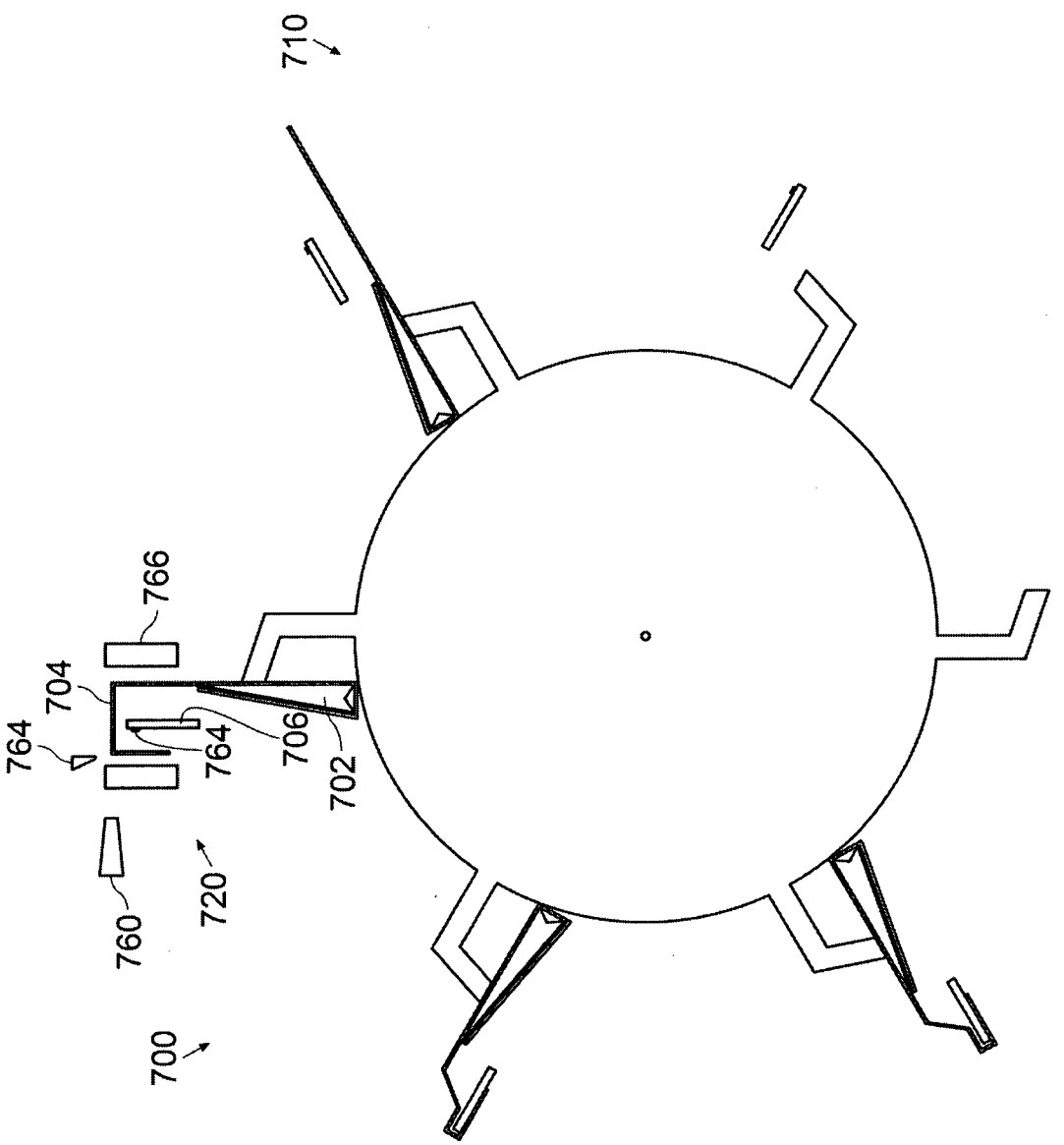

FIG. 7

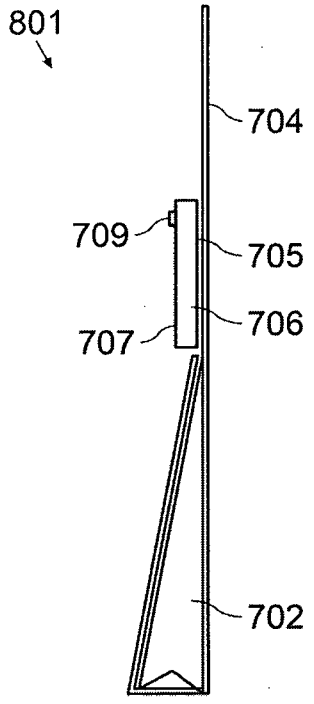

FIG. 8A

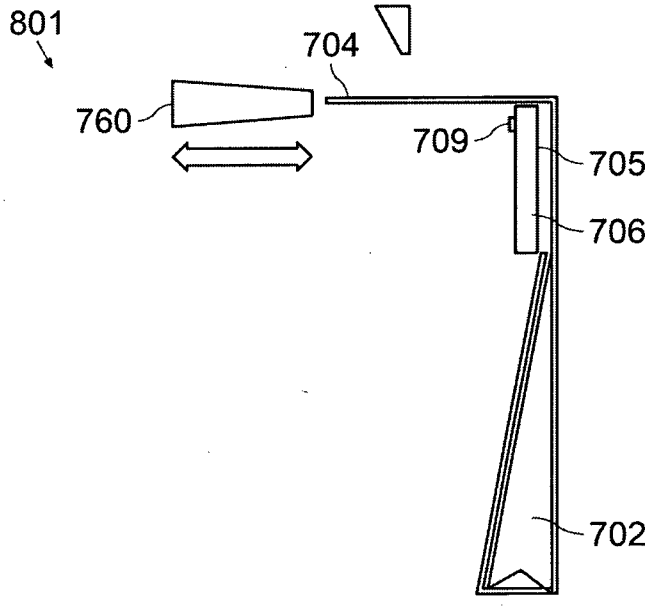

FIG. 8B

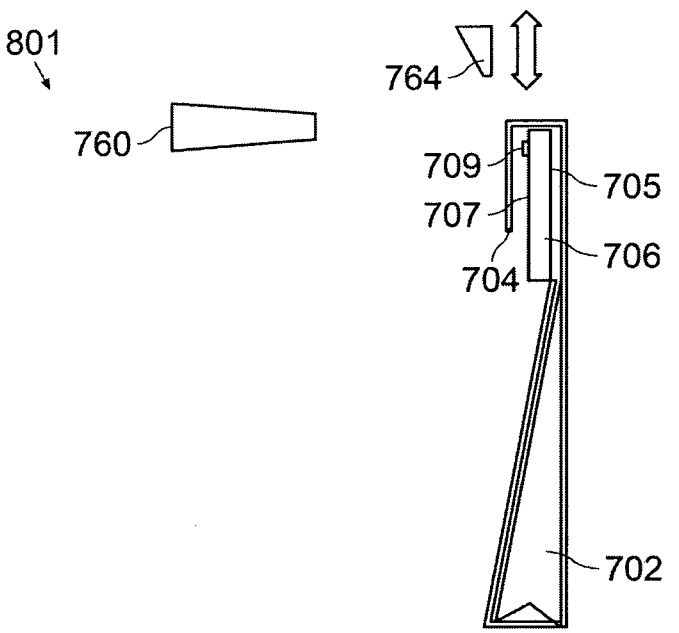
801
764
760
709
705
707
706
704
702

FIG. 8C

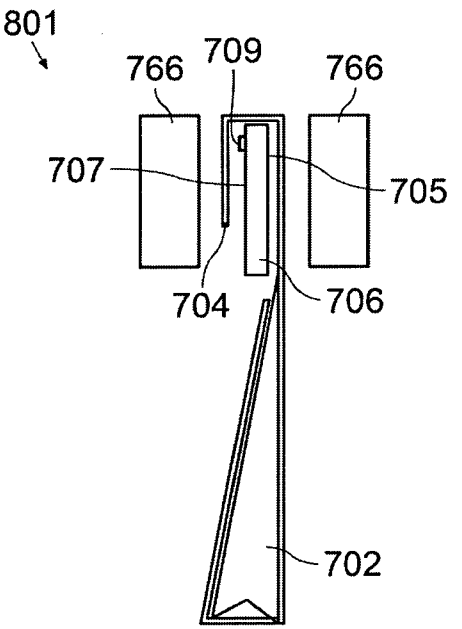
801
766
709
766
707
705
704
706
702

FIG. 8D

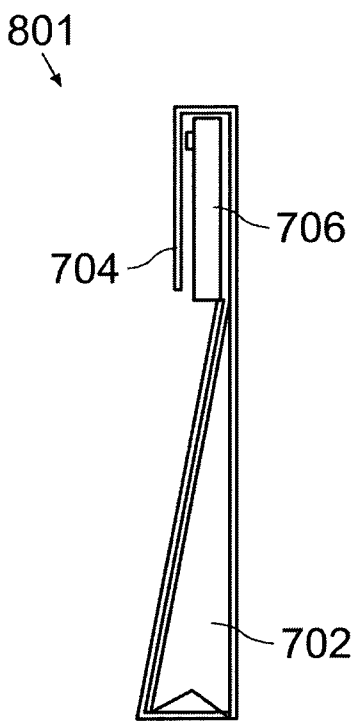

FIG. 8E

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/000255

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65B29/04
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)
B65B

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 2 274 622 A (WEST EDWARD E) 24 February 1942 (1942-02-24) the whole document	1-21
X	EP 1 522 496 A1 (KLAR PAUL GERHARD DR-ING [DE]) 13 April 2005 (2005-04-13) paragraph [0032] - paragraph [0044]; examples 22-25	15-21
A	DE 102 26 383 A1 (TECNOMECCANICA SRL [IT]) 19 December 2002 (2002-12-19) the whole document	1-21

☐ 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
17 July 2019	30/07/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Yazici, Baris

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2019/000255

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2274622 A	24-02-1942	NONE	
EP 1522496 A1	13-04-2005	AT 389585 T	15-04-2008
		EP 1522496 A1	13-04-2005
DE 10226383 A1	19-12-2002	DE 10226383 A1	19-12-2002
		IT BO20010382 A1	16-12-2002