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(54) SYNCHRONIZATION SYSTEM FOR ROVING FRAMES

(57) The invention relates to a synchronization system for fiber stretching devices of roving frames, of the type having the drive section only at one end. The synchronization system is configured to be coupled to the non-driving section of at least one motorized cylinder thereby reducing and/or cancelling out the lag or lead torsions generated by the natural forces and frictions of long fiber stretching devices during acceleration or deceleration, or due to variations in relative speed between the cylinders during normal operation.

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Description

TECHNICAL FIELD

[0001] The invention relates generally to the field of textile industries, and more specifically, to a synchronization system for a fiber stretching device, or system, of roving frames.

BACKGROUND ART

[0002] **FIG. 1** shows, by way of example, a fiber stretching device 100 for roving frames (also known as a drafting system) comprising, in this case, three motorized cylinders arranged in parallel in fixed positions and covering practically the entire length of the roving frame, and a plurality of presser arms perpendicular to the motorized cylinders, distributed along the roving frame, and provided with free-rotating rollers arranged in parallel with said motorized cylinders. The presser arms have first rollers and second free-rotating rollers, located parallel to and above the motorized cylinders, for pressing the fibers to be stretched.

[0003] The pressure exerted on the fibers and their driving at increasing speed in the direction of travel (downstream, as indicated by the arrow) causes the fibers to stretch before being twisted and wound onto spindles. The drive section 140 is located at the beginning of the roving frame (in this case, on the left of the figure) and comprises at least one electronically controlled motor to vary the rotation speed of each cylinder. Due to the characteristics of such drafting frames, such as different cylinder diameters, the distance between cylinders, or the desired degree of stretching, the cylinders rotate at different speeds. In regular operation, the cylinders are started at the same time, i.e., synchronously, and then accelerated to their respective operating speeds, where they maintain synchronization (albeit at different speeds).

[0004] The cylinders are typically arranged to rotate at different speeds. In a typical configuration, the third cylinder 130, further upstream, rotates more slowly than the second cylinder 120, and its function is to collect the fiber from the previous device and feed it into the drafting system. Therefore, in this context, the third cylinder 130 is referred to as the input cylinder. In turn, the second cylinder 120, in the middle, rotates more slowly than the first cylinder 110. Consequently, the first cylinder 110 rotates faster than the second 120 and third 130 cylinders. Due to its dimensions and those of its rollers, the second cylinder generates resistance to the movement of the fiber. Therefore, in this context, the second cylinder 120 is called the stretching cylinder. The first cylinder 110, further downstream, rotates the fastest and, together with the second cylinder, generates the stretch and drives the stretched fiber for collection on the spindles (not shown). Therefore, in this context, the first cylinder 110 is called the exit cylinder.

[0005] The starting material for the entire process is fibers made up of a plurality of thick fiber sections, for example, a mixture of cotton and plastic, which when stretched together form a thinner yarn. However, during this stretching process, the fiber can easily fray, even with the application of very light longitudinal force, as it is a highly delicate material. To prevent fraying, the fiber is twisted around itself, making it resistant to breakage along its main axis, resulting in a strong yarn. However, the more twisted the fiber is, and the more resistant it is to breakage, the more difficult and resistant it is to stretching. For this reason, the yarn manufacturing process is carried out in stages.

[0006] In an initial stage, the base material, that is, the unstretched fiber, which is usually wider than the desired final yarn width, is stretched to the required extent. In a later stage, the stretched yarn is twisted and other post-processing steps are applied to finish manufacturing the strong yarn. The degree of stretching depends both on the properties of the starting fiber and on the function or application of the final yarn, together with the post-processing steps according to the intended use.

[0007] The speed and rotational power of the motorized cylinders are carefully controlled, as otherwise this can result in excessive stretching of the fibers or even their breakage. This undesirable effect is heightened the more delicate the fiber being treated is, as the intrinsic strength of a fiber depends on its starting material. For this reason, stretching devices have a limited length, as it is difficult to precisely control the forces applied between the pressing arms, rollers, intermediate fibers, motors, and long cylinders of the drafting frame.

[0008] However, to produce a more efficient, higher-performance roving frame, it is desirable for the stretching device to be as long as possible, in order to incorporate the maximum number of stretching assemblies (presser arms and rollers) to stretch as many fibers as possible. Typically, existing long roving frames can reach approximately 50 meters in length and comprise cylinders of similar length. In the future, it may be possible to increase this length even further. In order to rotate such long structures in a controlled manner, existing solutions incorporate at least two motorized sections, one motorized section at each end, thus controlling the rotation of the cylinders at both ends. In this way, it has been possible to lengthen traditional stretching frames which were shorter.

[0009] However, this type of device has the disadvantage that controlling several motorized sections at both ends results in a more complicated design, as well as requiring different components at each end. One problem is that the motors at the ends lose synchronization and must be resynchronized periodically. Another problem is that it is extremely difficult to synchronize motors when the cylinders are so long, and therefore, some solutions divide the cylinder into sections to facilitate this process. This, together with the fact that all the components of the motor section are duplicated, and that more operating energy is consumed, such as maintenance costs, increases the production cost of the roving frame. Therefore, it is desirable to produce roving frames with the motorized section at only one end without losing the advantages of having the longest possible roving frame. Not only is it much easier to control the motorized section at only one end, but it also simplifies the design of the roving frame, reducing its overall operating and maintenance costs.

[0010] A significant problem with this type of roving frame, which has the drive section at one end but not at the other, is that torsion occurs between the two ends of each cylinder, along its longitudinal axis, varying between 5° and 20°, as shown **in FIG. 2.** That is, due to the length of the cylinders, as well as the different frictions and forces exerted along the cylinders by the plurality of presser arms and stretch actions, the cylinders undergo torsion, in addition to rotating. If the motorized end is identified with a torsion of 0°, the opposite, non-motorized end can have up to 20° of torsion. In addition, each cylinder undergoes slightly different torsions. The degree of torsion depends on the starting material of the fibers, the desired degree of stretch, the dimensions of the cylinders, and their rotation speeds.

[0011] The undesirable effect is that the fibers stretch differently along the cylinders. The fibers closest to the motorized section exhibit the best stretch quality, that is, they stretch as desired. However, gradually towards the other end, the stretching of the fibers can become so different that quality standards are not met, and the fibers have to be discarded, resulting in a significant loss of resources and manufacturing time. In the worst case, the fibers can break continuously.

[0012] Therefore, there is a need to effectively solve these problems.

SUMMARY OF THE INVENTION

[0013] It is an object of the invention to provide solutions to the aforementioned problems. In particular, it is an object of the invention to provide a synchronization system for stretching devices of the type having the drive section only at one end, which synchronization system reduces and/or cancels out the torsion generated by the natural forces and frictions of long devices. The invention is defined by the claims.

[0014] When accelerating the cylinders, the non-powered end lags behind the powered end, producing a lag torsion with a positive angle. This typically occurs when starting the igniter from a rest state. FIG. 2 shows a cylinder with lag torsion, wherein the dashed line 210 represents the longitudinal axis at rest, the dashed line 220 represents the torsioned longitudinal axis, and the angle α between the two axes is positive. When the cylinders decelerate, the non-driven end leads the driven end, producing a lag torsion with a negative angle. This typically occurs when stopping the roving frame from an operating state. It also happens that, during normal operation, when the cylinders rotate at their operating speeds, there may be variations in relative speed between the cylinders, generating lag or lead torsions. Therefore, the synchronization system comprises different aspects aimed at neutralizing this torsion in such cases.

BRIEF DESCRIPTION OF THE CONTENT OF THE DRAWINGS

[0015] The features and advantages of the present invention will become more apparent from the detailed description set forth below in conjunction with the drawings, in which like reference characters identify corresponding elements in different drawings. Corresponding elements may also be referenced by different characters.

FIG. 1 depicts, by way of example, a fiber stretching device for roving frames.

FIG. 2 depicts, by way of example, the degree of torsion suffered by a cylinder.

FIG. 3 represents the synchronization system applied to a roving frame with two cylinders for neutralizing a lag torsion.

FIG. 4 represents the synchronization system applied to a roving frame with two cylinders to a neutralize lead torsion.

FIG. 5 represents the synchronization system applied to a roving frame with three cylinders to neutralize both a lag and lead torsion.

FIG. 6 represents the tensor module.

FIG. 7 represents the synchronization system applied to a roving frame with two cylinders comprising additionally the tensor module.

FIG. 8 represents the synchronization system applied to a roving frame with three cylinders comprising additionally the tensor module.

DETAILED EXPLANATION OF THE INVENTION

[0016] The problem of torsion is particularly acute during cylinder rotation start-up (acceleration) or shutdown (deceleration). It is when they start up and accelerate to their respective operating speeds (or when they shut down and decelerate) that torsion in one or more cylinders causes different amounts of stretching along their length. However, as described, the cylinders also undergo torsion during regular operation due to differences in relative speed between the cylinders. These differences can occur due to the characteristics of the numerous yarns being stretched or also due to the movement of the plurality of presser arms operated during stretching, among other reasons.

[0017] To facilitate cylinder identification, the cylinder with less (or no) torsion relative to another cylinder will be called the "untorsion cylinder." The cylinder with the highest torsion relative to the other cylinder will be called the "torsion cylinder." This does not necessarily mean that it is torsioned, but rather that it may be subject to higher torsion if this undesirable effect is not remedied. Therefore, in operation, even if the synchronization system prevents the generation of torsion, this cylinder will still be referred to as the "torsion cylinder." Typically, there is one cylinder that, due to its speed and thickness characteristics, suffers from more torsion than the others. In the example in FIG. 1, since the yarn is stretched mainly between the stretching cylinder 120 and the exit cylinder 110, it is precisely the stretching cylinder 120 that suffers the most torsion and is therefore the most important to neutralize.

[0018] It should be noted that, in a textile factory, the normal operation of a long roving frame may need to be interrupted several times for fabric changes. Therefore, the problem described when starting up or stopping poses a serious inconvenience when operating a roving frame in a production environment. It would not be feasible to produce efficiently if every time the machine is stopped and restarted, an additional problem with product quality occurs.

[0019] To remedy this problem, among others, a synchronization system for stretching devices is provided. The synchronization system operates continuously, whether the relative speeds between cylinders are increasing or decreasing. Typically, when the cylinders accelerate, a lagging torsion occurs, mainly in the stretching cylinder. Conversely, when the cylinders are decelerated, a leading torsion occurs, also mainly in the stretching cylinder. These situations occur mainly when starting or stopping the stretching device, but they can also occur during regular operation.

[0020] The following section describes the details of the synchronization system, primarily using the case of lagging torsion. However, the synchronization system operates on the same mechanical principles as the case of leading torsion. Therefore, expressions such as "when starting," "when accelerating," or "during acceleration" will be used, but the description applies equally to the opposite direction, that is, "when stopping," "when decelerating," or "during deceleration."

[0021] The synchronization system comprises a set of pulleys and transmission belts that connect at least two motorized cylinders at their non-motorized ends, one of which is a torsion cylinder and the other an untorsion cylinder. When the rotational speed of the cylinders increases, the untorsion cylinder, through the synchronization system, immediately actuates, or drives, the torsion cylinder, compensating for any lag that could be caused by the torsion lag of the torsion cylinder. Once the difference in angular torsion has been compensated, the cylinders rotate in synchronization, each at its operating speed, according to the design. The same principle applies when the cylinders decelerate, and the synchronization system immediately drives the torsion cylinder, compensating for any lag that could be caused by the lead torsion of the torsion cylinder.

<u>Two cylinder use case</u>

[0022] **FIG. 3** shows two cylinders of a roving frame, to which the synchronization system 300 has been coupled, which synchronization system is configured to neutralize lead torsion during a deceleration process, or reduction of the relative speed between the two cylinders. The roving frame comprises a torsion cylinder 120 that is subjected to lead torsion, and an untorsion cylinder 110. The synchronization system comprises one module per cylinder, which are connected to each other by a belt that transmits the traction from the untorsion cylinder to the torsion cylinder, neutralizing the difference caused by the torsion. Each module comprises a shaft configured to couple to the end of the corresponding cylinder and rotate integrally with it. The shaft is configured with a pulley.

[0023] The pulley of the module corresponding to the untorsion cylinder is fixed, in the sense that it is integral with the axis of the module and therefore rotates integrally with its corresponding cylinder. However, the pulley of the module corresponding to the torsion cylinder is unidirectional free-rotating, in the sense wherein it rotates freely in only one direction, and in the opposite direction it does not rotate freely, but is driven along with its corresponding shaft. The pulleys have different diameters configured according to the desired pitch ratio between the cylinders. In this case, pulley 324 of torsion cylinder 120 has a larger diameter than pulley 314 of untorsion cylinder 110.

[0024] In the first module, which is coupled to the untorsion cylinder 110, the pulley 314 is fixedly arranged on the same shaft 312 of the first module. This can be implemented as a design feature of the same shaft (as shown in the figure) in the form of a toothed section of the shaft, or as a toothed roller that is integrally fixed to the shaft and therefore does not rotate freely. Regardless of the particular implementation, the pulley rotates together with and in the same direction as the untorsion cylinder.

[0025] In the second module, which is coupled to the torsion cylinder 120, the pulley 324 is arranged on the shaft 322 of the second module in such a way that the pulley is allowed to rotate freely in one direction only. The direction of free rotation of the pulley 324 of the second module is the same as the direction of rotation of the pulley 314 of the first module.

[0026] The first pulley 314 and the second pulley 324 are connected by a belt 330. That is, the belt 330 is configured to connect the two pulleys of both modules in such a way that it transmits traction from one pulley to the other. Both the pulleys and the belt comprise complementary coupling means for coupling the pulleys to the belt in such a way that traction is transmitted between the pulleys by means of the belt. In one example implementation, both the pulleys and the belt are toothed to connect the teeth in an interleaved manner. The skilled artisan will be aware of other particular implementations when configuring the coupling between pulleys and belt in such a way as to allow traction to be transmitted.

[0027] During normal operation, wherein both cylinders are rotating at their operating speeds, pulley 324 on the torsion cylinder rotates freely, as it is decoupled from the drive of the untorsion cylinder. As the roving frame slows down, when it descends below a certain rotational speed threshold, wherein the untorsion cylinder rotates at a lower speed than the torsion cylinder, the synchronization system is activated, in the sense that pulley 324 is locked and stops rotating freely, and consequently begins to transmit the traction of the untorsion cylinder received through the belt to the torsion cylinder. In this way, shaft 312 drives shaft 322 and neutralizes the lead torsion. Consequently, both cylinders are immediately synchronized when the cylinders decelerate, without even allowing time for any torsion to occur in the second cylinder 120, neutralizing the undesirable effect of torsion and preventing it from increasing.

[0028] This compensation prevents torsion from even beginning to occur, or if torsion does begin, it prevents the maximum degree of torsion from being reached. Consequently, both cylinders have been synchronized, without one suffering from a shift in relation to the other. This synchronization eliminates the difference caused by the angular torsion between the cylinders, resulting in a regular and predictable degree of stretching throughout the entire roving frame, which is reflected in high-quality textile manufacturing. Based on these lessons, a skilled artisan would know how to configure the synchronization modules by changing them from cylinder to cylinder in the event that the torsion cylinder were the downstream cylinder 110.

[0029] **FIG. 4** shows two cylinders of a roving frame, to which the synchronization system 400 has been coupled, which synchronization system is configured to neutralize a lag torsion during an acceleration process, or increase in the relative speed between the two cylinders. The roving frame comprises a torsion cylinder 120 that is subjected to a lag torsion, and an untorsion cylinder 130. The synchronization system comprises one module per cylinder, which are joined together by a belt that transmits the traction from the untorsion cylinder to the torsion cylinder, neutralizing the difference caused by the torsion. Each module comprises a shaft configured to engage with the end of the corresponding cylinder and rotate integrally with it. The shaft is configured with a pulley.

[0030] The pulley of the module corresponding to the untorsion cylinder is fixed, in the sense that it is integral with the axis of the module and therefore rotates integrally with its corresponding cylinder. However, the pulley of the module corresponding to the torsion cylinder is unidirectional free-rotating, in the sense that it rotates freely in only one direction, and in the opposite direction it is driven along with its corresponding shaft (it does not rotate freely). The pulleys have different diameters configured according to the desired pitch ratio between the cylinders. In this case, pulley 424 of the torsion cylinder 120 has a larger diameter than pulley 434 of the untorsion cylinder 130.

[0031] In the third module, which is coupled to the untorsion cylinder 130, the pulley 434 is fixedly arranged on the same shaft 432 of the third module. This can be implemented as a design feature of the same shaft (as shown in the figure) in the form of a toothed section of the shaft, or as a toothed roller that is integrally fixed to the shaft and therefore does not rotate freely. Regardless of the particular implementation, the pulley rotates together with and in the same direction as the untorsion cylinder.

[0032] In the second module, which is coupled to the torsion cylinder 120, the pulley 424 is arranged on the shaft 322 of the second module in such a way that the pulley is allowed to rotate freely in one direction only. The direction of free rotation of the pulley 424 of the second module is opposite to the direction of rotation of the pulley 434 of the third module.

[0033] Pulley 434 of the third module and pulley 424 of the second module are connected by a belt 430. That is, a belt 430 is configured to connect the two pulleys of both modules in such a way that it transmits traction from one pulley to the other. Both the pulleys and the belt comprise complementary coupling means for coupling the pulleys to the belt in such a way that traction is transmitted between the pulleys by means of the belt. In one example implementation, both the pulleys and the belt are toothed to connect the teeth in an interleaved manner. The skilled artisan will be aware of other particular implementations when configuring the coupling between pulleys and belt in such a way as to allow traction to be transmitted.

[0034] During normal operation, wherein both cylinders are rotating at their operating speeds, pulley 424 on the torsion cylinder rotates freely, as it is decoupled from the drive of the untorsion cylinder. As acceleration increases and a certain threshold of relative speed between cylinders is exceeded, the synchronization system is activated, in the sense that pulley 424 is locked and stops rotating freely, and consequently begins to transmit the drive from the untorsion cylinder received via the belt to the torsion cylinder. In this way, shaft 432 drives shaft 322 and neutralizes the lag torsion. Thus, both cylinders are immediately synchronized when the cylinders accelerate, without even allowing time for any torsion to occur in the second cylinder 120, neutralizing the undesirable effect of torsion and preventing it from increasing.

[0035] As acceleration continues, when the second cylinder 120 reaches its operating speed, since this speed is higher than the operating speed of the third cylinder 130, pulley 424 of the second module begins to rotate freely, decoupling the second module from the third module. At this point, both cylinders have been synchronized and operate at their operating speeds according to design, but independently.

[0036] This compensation prevents torsion from even beginning to occur, or if torsion does begin, it prevents the maximum degree of torsion from being reached. Consequently, both cylinders have been synchronized, without one suffering from a shift in relation to the other. Hence, this synchronization eliminates the difference caused by the angular torsion between the cylinders, resulting in a regular and predictable degree of stretching throughout the entire roving frame, which is reflected in high-quality textile manufacturing. Based on these teachings, a skilled artisan would know how to configure the synchronization modules by changing them from cylinder to cylinder if the torsion cylinder were the upstream cylinder 130.

Three cylinder use case

[0037] **FIG. 5** shows the synchronization system 500 applied to a three-cylinder roving frame comprising at least one torsion cylinder 120, wherein the synchronization system is configured to neutralize a lag torsion during an acceleration process, or increase in the relative speed between two cylinders, as well as to neutralize a lead torsion during a deceleration process, or reduction in the relative speed between two cylinders.

[0038] This configuration is quite common, as the input third cylinder 130 feeds the fiber to the stretching device and the exit first cylinder 110 feeds it out of the device, while the stretching of the fiber is mainly achieved through the collaboration between the second cylinder 120, which performs the stretching, and the first cylinder 110.

[0039] The system comprises one module per cylinder, wherein the cylinders are connected to each other by a belt that transmits traction from one cylinder to the other, neutralizing the difference caused by torsion. Each module comprises a shaft configured to couple to the end of the corresponding cylinder and rotate integrally with it. The shaft is configured with a pulley.

[0040] The configuration of the first and second modules is the same as in the aspect of FIG. 3, and the configuration of the second and third modules is the same as in the aspect of FIG. 4. Therefore, the first pulley 324 of the second module (which in this aspect is also identified as the third pulley) is arranged on the second shaft 322 adjacent to, but without contacting, the second pulley 424 of the second module (which in this aspect is also identified as the fourth pulley). Therefore, two unidirectional pulleys (324, 424) are attached to the second shaft 322 of the second module, which are connected to the corresponding pulleys (314, 434) of the two adjacent shafts (312, 432, on each side) by means of corresponding belts (330, 430). The two pulleys of the second cylinder are blocked in opposite directions, that is, they are configured to rotate freely in opposite directions (while one is driven, the other rotates freely).

[0041] Both the pulleys and the belts comprise complementary coupling means for coupling the pulleys to the belts in such a way that traction is transmitted between the pulleys by means of their respective belts. In one example implementation, both the pulleys and the belts are toothed so that the teeth engage in an interleaved manner. The skilled artisan will be aware of other specific implementations when configuring the coupling between pulleys and belt in such a way as to allow traction to be transmitted.

[0042] The pulleys have different diameters configured according to the pitch ratio between the cylinders. In this case, pulley 324 of the second cylinder 120 has a larger diameter than pulley 314 of the first cylinder 110 and pulley 434 of the third cylinder 130. In addition, pulley 434 of the third cylinder 130 has a larger diameter than pulley 314 of the first cylinder 110 but a smaller diameter than the second pulley 424 of the second cylinder 120. Both pulleys on the second module have similar or equal diameters.

[0043] During operation, that is, as the three cylinders accelerate, the rotation of the third module caused by the rotation of the third cylinder 130 is immediately transmitted via the shaft and pulleys to the second module, whose shaft 322 rotates and drives the torsion cylinder via its second pulley 424, which is locked. On the other hand, the second pulley 324 is in a free-rotating state and therefore does not cause any drive. In this way, the lead torsion of the second stretching cylinder is neutralized, and the three cylinders are immediately synchronized when the cylinders are accelerated, without even allowing time for any torsion to occur in the second cylinder 120, neutralizing the undesirable effect of torsion and preventing it from increasing.

[0044] However, as they slow down, the rotation of the first module caused by the rotation of the first cylinder 110 is immediately transmitted via the shaft and pulleys to the second module, whose shaft 322 rotates and drives the torsion cylinder via the second pulley 324, which is locked. On the other hand, the third pulley 424 is in a free-rotating state and therefore does not cause any drive. This neutralizes the lag torsion of the second stretching cylinder, and the three cylinders are immediately synchronized when the cylinders slow down, without even allowing time for any torsion to occur in the second cylinder 120, neutralizing the undesirable torsion effect and preventing it from increasing.

[0045] In both cases, acceleration and deceleration, when the second cylinder 120 reaches its operating speed, the second 324 and third 424 pulleys begin to rotate freely, decoupling the second module from the first or third module, as appropriate. At this point, the three cylinders are synchronized and operate at operating speeds according to design, but independently.

[0046] This compensation prevents the maximum degree of torsion from being reached, or even from torsion beginning to occur. Consequently, all cylinders are synchronized, without one suffering from a shift in relation to the other. This synchronization eliminates the difference caused by the angular torsion between the cylinders, resulting in a regular and predictable degree of stretching throughout the entire roving frame, which translates into high-quality textile manufacturing. Based on these teachings, a skilled artisan would know how to configure the synchronization modules by changing them from cylinder to cylinder in the event that the torsion cylinder was another one.

Tensor module

[0047] Each stretching device will have a specific spacing between cylinders, which depends on the desired degree of stretching according to the properties of the fiber in question, the diameter of the cylinders, their respective speeds, and other parameters. If the belts of the synchronization system modules are not tensioned according to the spacing between cylinders, the synchronization functionality will not be optimal.

[0048] For this reason, the synchronization system also includes a tensor module. The tensor module is configured so that the synchronization system modules can also be adapted to this variable spacing, thereby optimizing the functionality of the synchronization system. In particular, the main function of the tensor module is to ensure that the belts are adequately tensioned according to the spacing between cylinders.

[0049] **FIG. 6** shows a tensor module 600 as part of the synchronization system. The tensor module comprises a main shaft and at least one vertical arm. The main shaft 610 is arranged parallel to the transverse axis of the stretching device, that is, parallel to the upstream-downstream direction, and is fixedly and solidly connected to the structure of the stretching device. The vertical arm connects the distal end of the synchronization module to the main shaft of the tensor module, also in a fixed and solid manner. The upper part of the vertical arm comprises a free-rotating roller, hereinafter referred to as the tensor roller, which is arranged in the first and/or third modules (which have the untorsion cylinders), on the inside of the belt and on which the belt of the synchronization module rests. In operation, the belt rotates on the two pulleys and the tensor roller.

[0050] To correctly tension the belt according to the distance between the cylinders, the tensor roller is moved, thus providing more or less rigidity to the belt. This movement is achieved by varying the distance between the synchronization modules. To do this, the main shaft 610 of the tensor module 600 is configured with a central guide 615 in the form of an elongated slot through which the distal end of the third synchronization module can be movably secured, for example, by means of screws and nuts. The screw and nut assembly allows the third synchronization module to be moved transversely, adding or removing distance between the synchronization modules, and consequently tensioning or untensioning the belt.

[0051] FIG. 6 shows a tensor module comprising a first vertical arm 620 supporting a first tensor roller 630 corresponding to the first synchronization module and another vertical arm 640 supporting another tensor roller 650 corresponding to the third synchronization module. Another vertical arm can also be attached for the second synchronization module (not shown). The tensor module not only allows the synchronization system to be configured for variable spacing between cylinders, but also ensures that this spacing is maintained despite the multiple starts and stops that will occur during operation.

[0052] **FIG. 7** shows two cylinders of a roving frame, to which the synchronization system 700 has been coupled to, the system additionally comprising a tensor module. In this regard, the tensor module is applied to the aspect of FIG. 3, wherein the main shaft 610, which is integrally fixed to the structure of the stretching device by means of the fastening 640, supports the vertical arm 620 and the tensor roller 630.

[0053] FIG. 8 shows the synchronization system 800 applied to a three-cylinder roving frame, with the system additionally comprising a tensor module. In this regard, the tensor module is applied to the aspect of FIG. 4, wherein the main shaft 610, which is integrally fixed to the structure of the stretching device by means of the fastening 640, supports the vertical arm 620 and the tensor roller 630 as well as the vertical arm 820 and the tensor roller 830. While the first tensor roller 630 tenses the first belt 330, the second tensor roller 830 tenses the second belt 430.

[0054] Therefore, the different aspects of the invention described allow the undesirable effect of torsion produced in long roving frame cylinders of the type whose traction section is located only at one end, leaving the other end of the cylinders free, to be neutralized. This synchronization eliminates the difference caused by angular torsion between the cylinders, resulting in a regular and predictable degree of stretch throughout the entire roving frame, resulting in high-quality textile manufacturing as well as an efficient manufacturing process without unnecessary losses.

[0055] What has been described comprises several embodiments by way of example. As it is neither possible nor feasible to describe all variations of combinations and permutations of the inventive concept which would result in a large number of embodiments, and redundant paragraphs, it is understood that, after a straightforward and objective reading of this disclosure, the skilled artisan would derive these various possible permutations and combinations from the various embodiments and aspects described. Consequently, it is intended to embrace all such alterations, modifications and variations that fall within the scope of the appended claims. The skilled artisan would understand that the description of the embodiments presented does not limit the invention, nor do the drawings.

[0056] In the following, certain additional aspects or examples are described:

A synchronization system for a stretching device of the type comprising at least two motorized cylinders arranged in parallel in fixed positions and wherein the drive section for actuating the at least two motorized cylinders is arranged only at one of the two ends of the stretching device, wherein the system is configured to be coupled to the other non-motorized end of the stretching device, the system comprising: a shaft per cylinder configured to be coupled to the non-motorized end of the cylinder and rotate integrally with it, and wherein the shaft is configured with a pulley; and a transmission belt configured to connect two pulleys corresponding to two shafts in such a manner that traction is transmitted between the corresponding cylinders.

[0057] The system, wherein both the pulleys and the belt are configured with complementary coupling means, for example, they are toothed so that the teeth connect in an interleaved manner. The system, wherein the first pulley is configured on the shaft coupled to the cylinder subject to less torsion, and wherein the second pulley is configured on the shaft coupled to the cylinder subject to more torsion. The system, wherein the first pulley is fixed and configured to rotate together with and in the same direction as its corresponding shaft, while the second pulley is unidirectional and arranged in such a way that it allows the pulley to rotate freely in one direction only. The system, wherein, in the case where the first pulley is located upstream of the second pulley, the free rotation direction of the second unidirectional pulley is opposite to the drive direction of the first pulley, and wherein, in the case where the first pulley is located downstream of the second pulley, the free rotation direction of the second unidirectional pulley is the same as the drive direction of the first pulley. The system, further comprising a third motorized cylinder arranged in parallel in a fixed position on the other side of the second cylinder in relation to the first cylinder, the system further comprising a third shaft configured to engage with the non-motorized end of the third cylinder and rotate integrally with it, and wherein the third shaft is configured with a third pulley, wherein the second shaft further comprises a fourth pulley, and wherein the system further comprises a second transmission belt configured to connect the third and fourth pulleys corresponding to the third and second shafts, respectively, such that traction is transmitted between the corresponding cylinders. The system, wherein the third pulley is configured on the third shaft coupled to the cylinder subject to less torsion and wherein the fourth pulley is configured on the second shaft coupled to the cylinder subject to more torsion. The system, wherein the third pulley is fixed and configured to rotate together with and in the same direction as its corresponding shaft, while the fourth pulley is unidirectional and arranged in such a way that the pulley is allowed to rotate in one direction only, but not in the opposite direction. The system, wherein the free rotation direction of the fourth pulley is opposite to the drive direction of the third pulley. The system, wherein the pulleys are configured with diameters according to the predefined draft ratio between the cylinders. The system, further comprising at least one tensor module configured to adequately tension the belt based on the spacing between cylinders, wherein the at least one tensor module is configured to engage the first shaft of the first cylinder and/or the third shaft of the third cylinder. The system, wherein the at least one tensor module comprises at least one vertical arm, wherein the upper part of the vertical arm comprises a free-rotating roller arranged on the inside of the belt and on which the belt rests when rotating between the two pulleys, wherein the at least one tensor module additionally comprises a main shaft to which the vertical arm is coupled, the main shaft being attached to the stretching device in such a way as to allow the free-rotating roller to move transversely to the stretching device, allowing the belt to be stretched appropriately depending on the spacing between cylinders. The system, wherein the at least one tensor module comprises two vertical arms, one corresponding to the first cylinder and the other to the third cylinder, allowing both belts to be adequately tensioned depending on the spacing between cylinders.

[0058] A synchronization method for a stretching device, of the type comprising at least two motorized cylinders arranged in parallel in fixed positions and wherein the drive section for actuating the at least two motorized cylinders is arranged only at one of the two ends of the stretching device, wherein the system is configured to couple to the other non-motorized end of the stretching device, the method comprising: coupling, per cylinder, a shaft and a pulley that rotates together with the shaft to the non-motorized end of the cylinder; and connecting two pulleys corresponding to two shafts with a transmission belt and transmitting traction between the corresponding cylinders.

[0059] The method, wherein a first pulley is fixed and rotates together with and in the same direction as its corresponding shaft, while a second pulley is unidirectional and rotates freely in one direction only. The method, wherein the first pulley is configured on the shaft coupled to the cylinder subject to less torsion, and wherein the second pulley is configured on the shaft coupled to the cylinder subject to more torsion. The method, wherein, in the case where the first pulley is located upstream of the second pulley, the free rotation direction of the second unidirectional pulley is opposite to the drive direction of the first pulley, and, in the case where the first pulley is located downstream of the second pulley, the free rotation direction of the second unidirectional pulley is the same as the drive direction of the first pulley. The method, further comprising coupling a third motorized cylinder in parallel in a fixed position on the other side of the second cylinder in relation to the first cylinder, further comprising coupling a third shaft and a pulley to the non-motorized end of the third cylinder that rotate integrally with the shaft, and wherein the third shaft is configured with a third pulley, wherein the second shaft further comprises a fourth pulley, and wherein the method further comprises connecting the third and fourth pulleys corresponding to the third and second shafts, respectively, by means of a second transmission belt such that traction is transmitted between the corresponding cylinders. The method, comprising coupling the third pulley onto the third shaft coupled to the cylinder subject to less torsion and coupling the fourth pulley onto the second shaft coupled to the cylinder subject to more torsion. The method, wherein the third pulley is fixed and rotates together with and in the same direction as its corresponding shaft, while the fourth pulley is unidirectional and rotates in one direction only, but not in the opposite direction. The method, in which the fourth pulley rotates in a free rotation direction opposite to the drive direction of the third pulley. The method, further comprising adequately tensioning the belt depending on the spacing between cylinders by at least one tensor module, wherein the at least one tensor module is coupled to the first shaft of the first cylinder and/or to the third shaft of the third cylinder. The method, wherein the belt is supported between the two pulleys on a free-rotating roller located on the inside of the belt and on which at least one vertical arm is supported, and moving the free-rotating roller transversely to the tensor device, allowing the belt to be tensioned appropriately depending on the spacing between cylinders. The method, comprising tensioning both belts as a function of the spacing between cylinders using two vertical arms of the at least one tensor module, one corresponding to the first cylinder and the other to the third cylinder.

[0060] A fiber stretching device, such as a roving frame, comprising at least one synchronization system.

Claims

1. A synchronization system for a stretching device of the type comprising at least two motorized cylinders arranged in parallel in fixed positions and wherein the drive section for actuating the at least two motorized cylinders is arranged only at one of the two ends of the stretching device, wherein the system is configured to be coupled to the other non-motorized end of the stretching device, the system comprising:

   a shaft per cylinder configured to be coupled to the non-motorized end of the cylinder and rotate integrally with it, and wherein the shaft is configured with a pulley; and

   a transmission belt configured to connect two pulleys corresponding to two shafts in such a manner that traction is transmitted between the corresponding cylinders.

2. The system of claim 1, wherein both the pulleys and the belt are configured with complementary coupling means, for example, they are toothed so that the teeth connect in an interleaved manner.

3. The system of claim 2, wherein the first pulley is configured on the shaft coupled to the cylinder subject to less torsion, and wherein the second pulley is configured on the shaft coupled to the cylinder subject to more torsion, wherein the first pulley is fixed and configured to rotate together with and in the same direction as its corresponding shaft, while the second pulley is unidirectional and arranged in such a way that it allows the pulley to rotate freely in one direction only.

4. The system of claim 3,

   wherein, in the case where the first pulley is located upstream of the second pulley, the free rotation direction of the second unidirectional pulley is opposite to the drive direction of the first pulley, and

   wherein, in the case where the first pulley is located downstream of the second pulley, the free rotation direction of the second unidirectional pulley is the same as the drive direction of the first pulley.

5. The system of claim 1, further comprising a third motorized cylinder arranged in parallel in a fixed position on the other side of the second cylinder in relation to the first cylinder, the system further comprising a third shaft configured to engage with the non-motorized end of the third cylinder and rotate integrally with it, and wherein the third shaft is configured with a third pulley, wherein the second shaft further comprises a fourth pulley, and wherein the system further comprises a second transmission belt configured to connect the third and fourth pulleys corresponding to the third and second shafts, respectively, such that traction is transmitted between the corresponding cylinders, wherein the third pulley is configured on the third shaft coupled to the cylinder subject to less torsion and wherein the fourth pulley is configured on the second shaft coupled to the cylinder subject to more torsion, wherein the third pulley is fixed and configured to rotate together with and in the same direction as its corresponding shaft, while the fourth pulley is unidirectional and arranged in such a way that the pulley is allowed to rotate in one direction only, but not in the opposite direction.

6. The system of claim 5, wherein the free rotation direction of the fourth pulley is opposite to the drive direction of the third pulley.

7. The system of claim 1, further comprising at least one tensor module configured to adequately tension the belt based on the spacing between cylinders, wherein the at least one tensor module is configured to engage the first shaft of the first cylinder and/or the third shaft of the third cylinder.

8. The system of claim 7,

wherein the at least one tensor module comprises at least one vertical arm, wherein the upper part of the vertical arm comprises a free-rotating roller arranged on the inside of the belt and on which the belt rests when rotating between the two pulleys, wherein the at least one tensor module additionally comprises a main shaft to which the vertical arm is coupled, the main shaft being attached to the stretching device in such a way as to allow the free-rotating roller to move transversely to the stretching device, allowing the belt to be stretched appropriately depending on the spacing between cylinders;
or wherein the at least one tensor module comprises two vertical arms, one corresponding to the first cylinder and the other to the third cylinder, allowing both belts to be adequately tensioned depending on the spacing between cylinders.

9. A synchronization method for a stretching device of claim 1, of the type comprising at least two motorized cylinders arranged in parallel in fixed positions and wherein the drive section for actuating the at least two motorized cylinders is arranged only at one of the two ends of the stretching device, wherein the system is configured to couple to the other non-motorized end of the stretching device, the method comprising:

coupling, per cylinder, a shaft and a pulley that rotates together with the shaft to the non-motorized end of the cylinder; and
connecting two pulleys corresponding to two shafts with a transmission belt and transmitting traction between the corresponding cylinders.

10. The method of claim 9, wherein a first pulley is fixed and rotates together with and in the same direction as its corresponding shaft, while a second pulley is unidirectional and rotates freely in one direction only, wherein the first pulley is configured on the shaft coupled to the cylinder subject to less torsion, and wherein the second pulley is configured on the shaft coupled to the cylinder subject to more torsion.

11. The method of claim 10, wherein,

in the case where the first pulley is located upstream of the second pulley, the free rotation direction of the second unidirectional pulley is opposite to the drive direction of the first pulley, and
in the case where the first pulley is located downstream of the second pulley, the free rotation direction of the second unidirectional pulley is the same as the drive direction of the first pulley.

12. The method of claim 9, further comprising coupling a third motorized cylinder in parallel in a fixed position on the other side of the second cylinder in relation to the first cylinder, further comprising coupling a third shaft and a pulley to the non-motorized end of the third cylinder that rotate integrally with the shaft, and wherein the third shaft is configured with a third pulley, wherein the second shaft further comprises a fourth pulley, and wherein the method further comprises connecting the third and fourth pulleys corresponding to the third and second shafts, respectively, by means of a second transmission belt such that traction is transmitted between the corresponding cylinders, comprising coupling the third pulley onto the third shaft coupled to the cylinder subject to less torsion and coupling the fourth pulley onto the second shaft coupled to the cylinder subject to more torsion, wherein the third pulley is fixed and rotates together with and in the same direction as its corresponding shaft, while the fourth pulley is unidirectional and rotates in one direction only, but not in the opposite direction.

13. The method of claim 12, in which the fourth pulley rotates in a free rotation direction opposite to the drive direction of the third pulley.

14. The method of claim 9, further comprising adequately tensioning the belt depending on the spacing between cylinders by at least one tensor module, wherein the at least one tensor module is coupled to the first shaft of the first cylinder and/or to the third shaft of the third cylinder.

15. The method of claim 14,

wherein the belt is supported between the two pulleys on a free-rotating roller located on the inside of the belt and on which at least one vertical arm is supported, and moving the free-rotating roller transversely to the tensor device, allowing the belt to be tensioned appropriately depending on the spacing between cylinders;
or comprising tensioning both belts as a function of the spacing between cylinders using two vertical arms of the at least one tensor module, one corresponding to the first cylinder and the other to the third cylinder.

16. A fiber stretching device, such as of a roving frame, comprising at least one synchronization system according to the claim 1.

FIG. 1

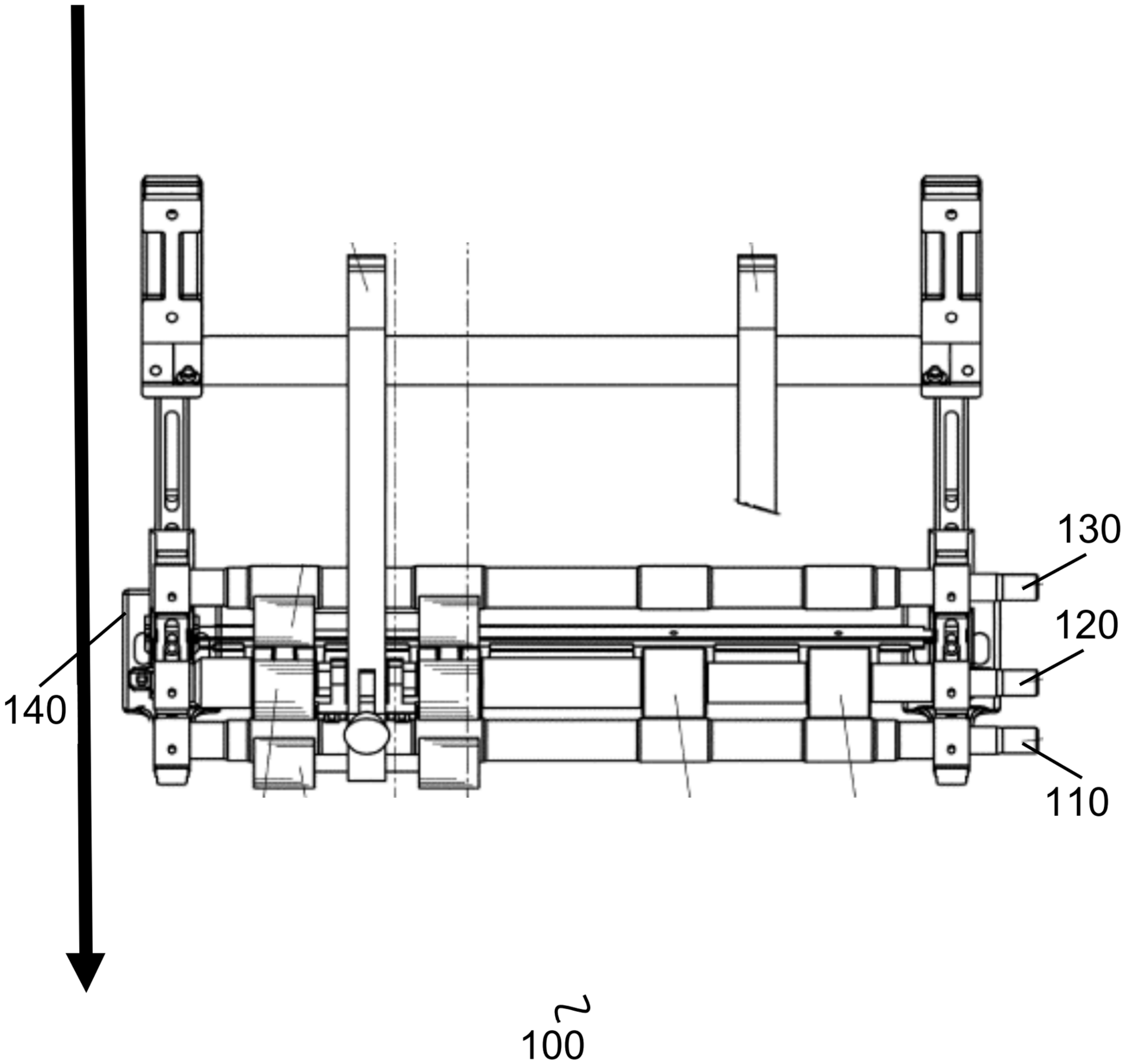


FIG. 2

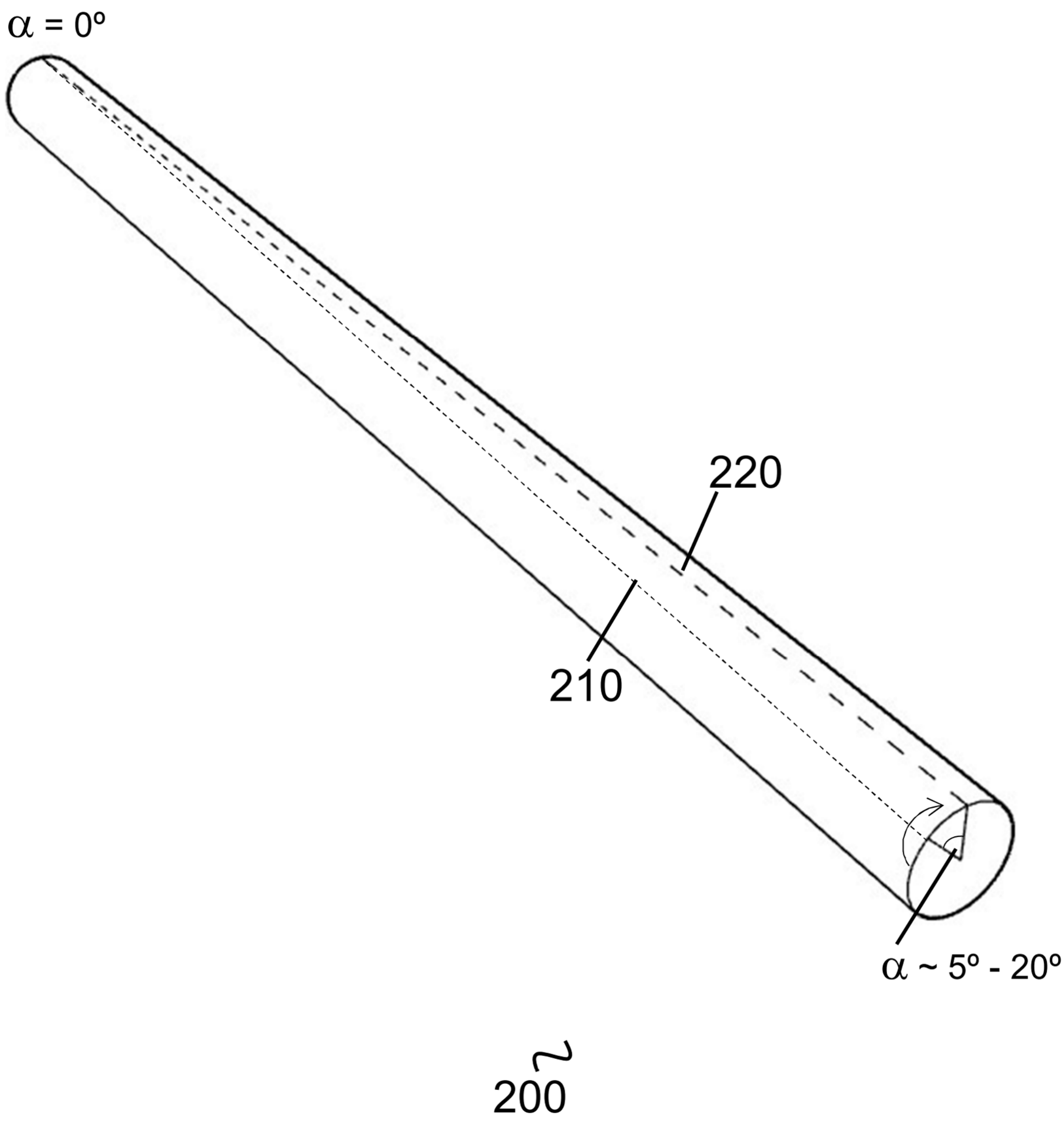


FIG. 3

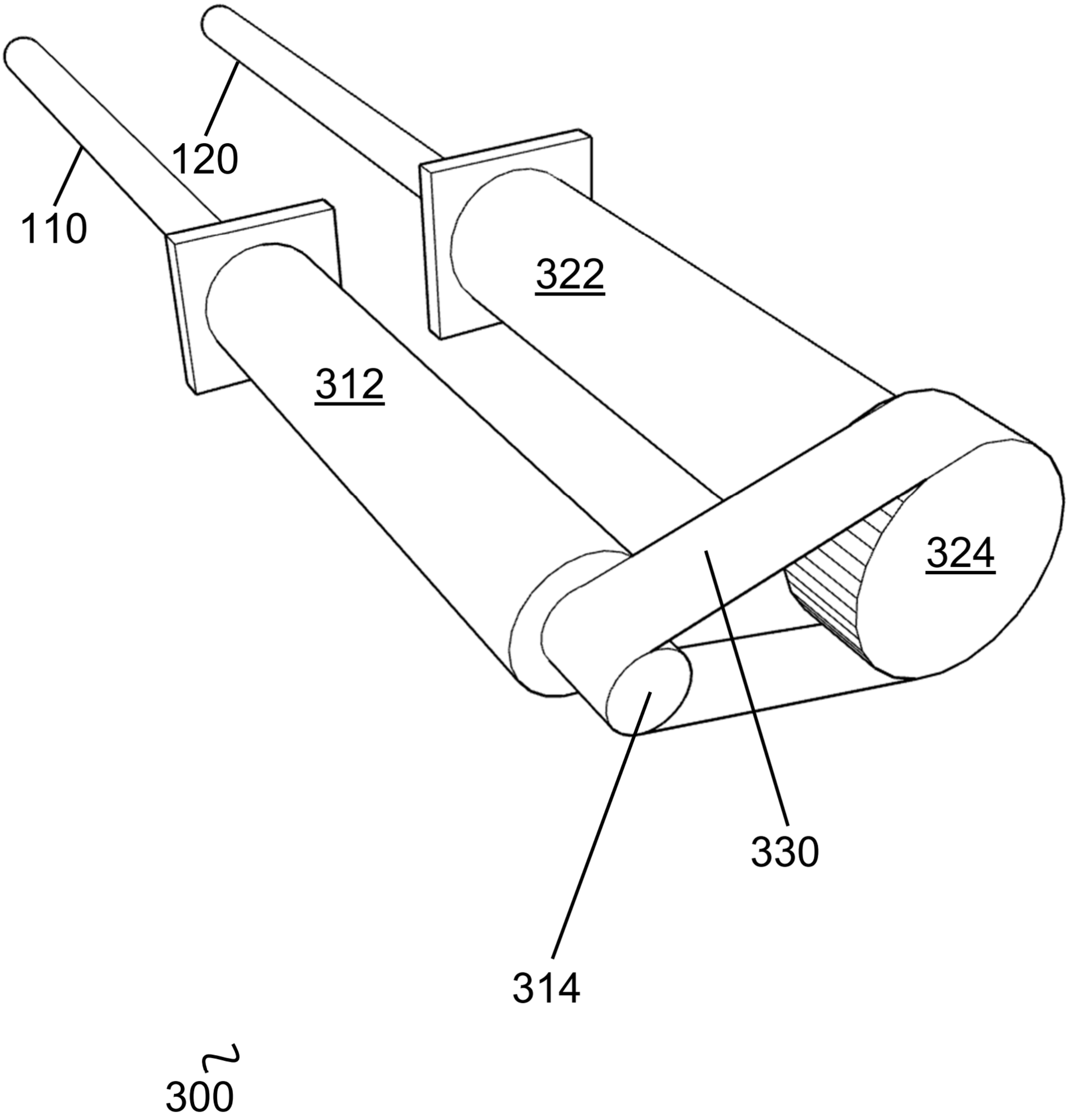


FIG. 4

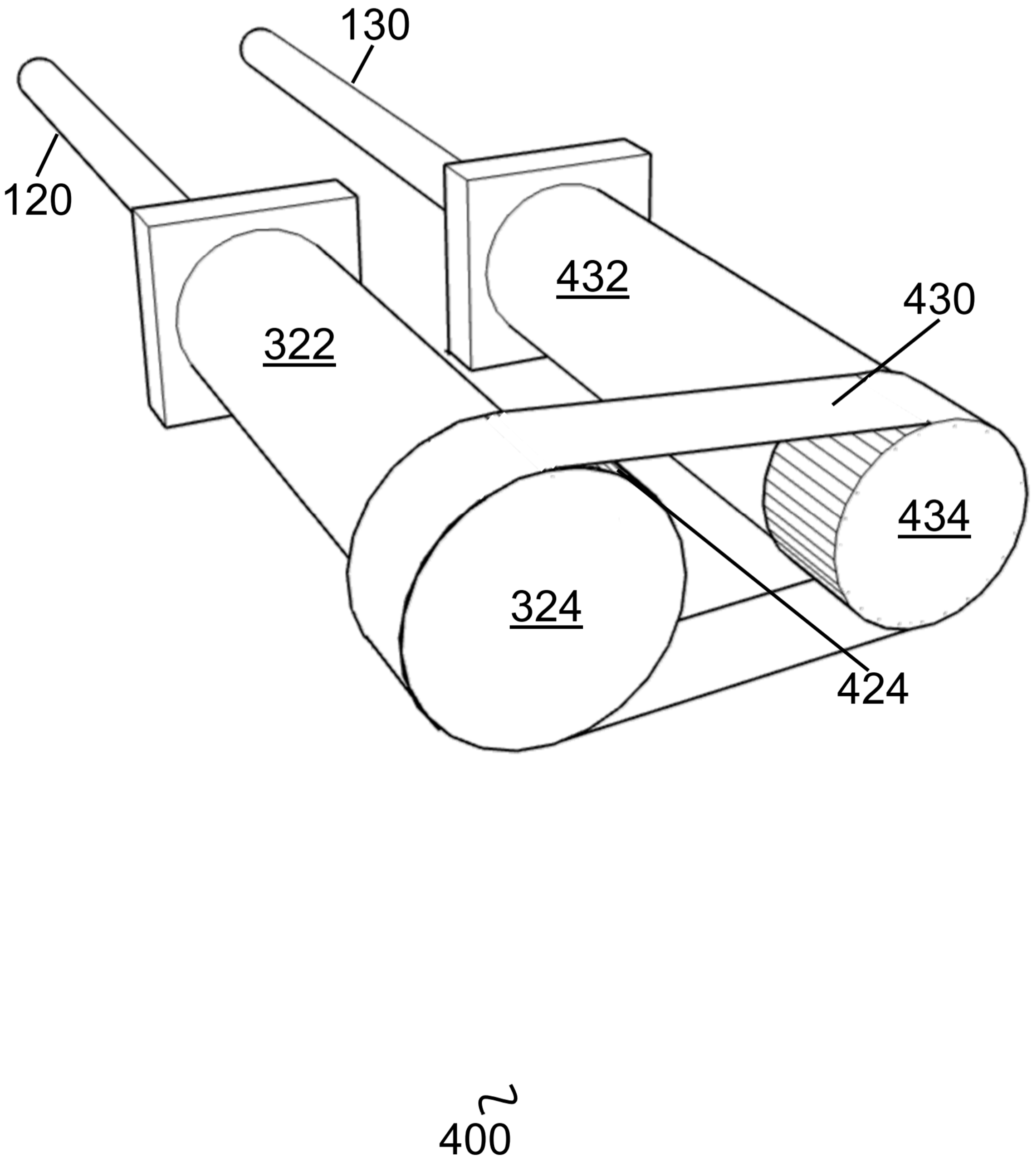


FIG. 5

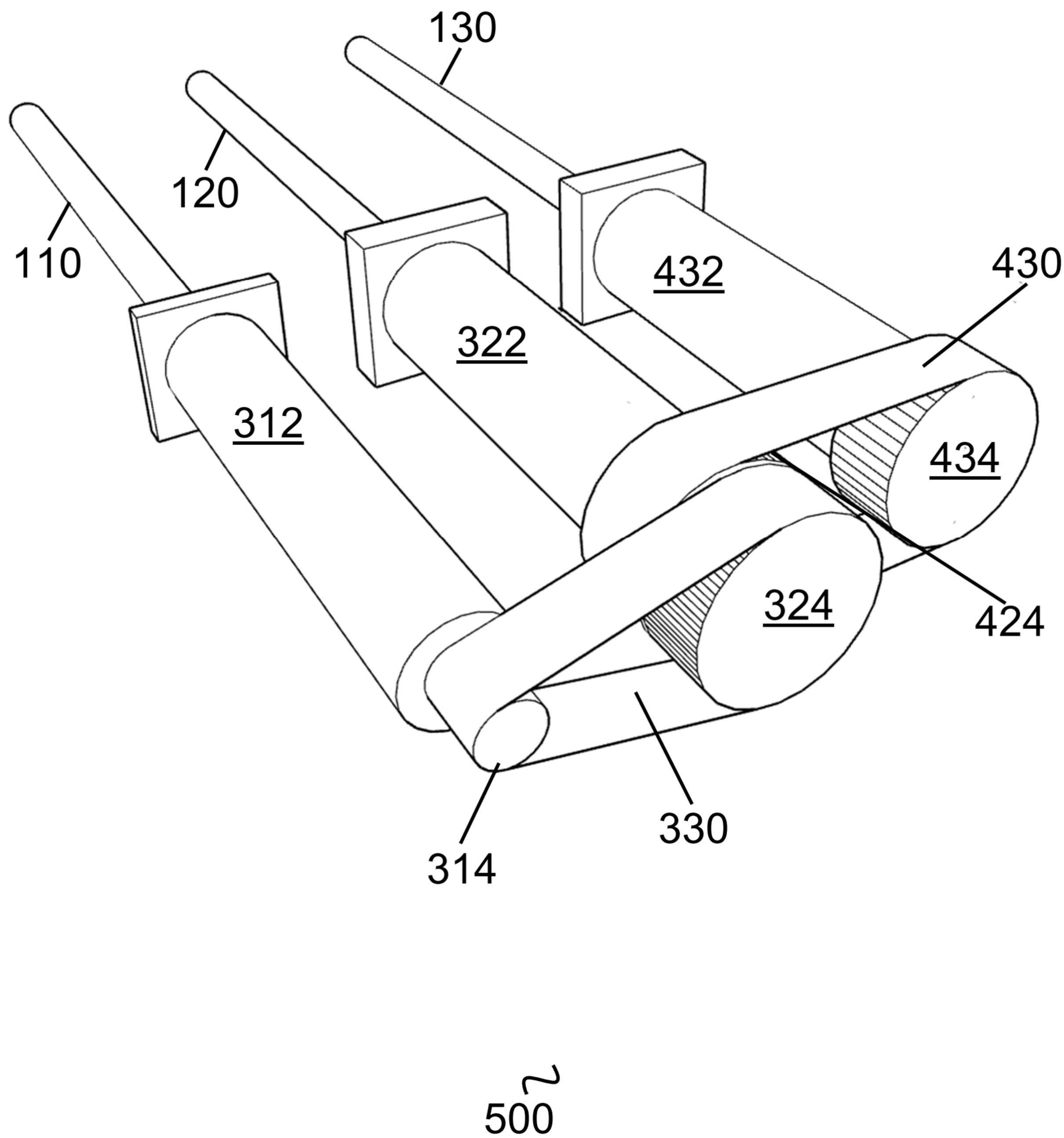


FIG. 6

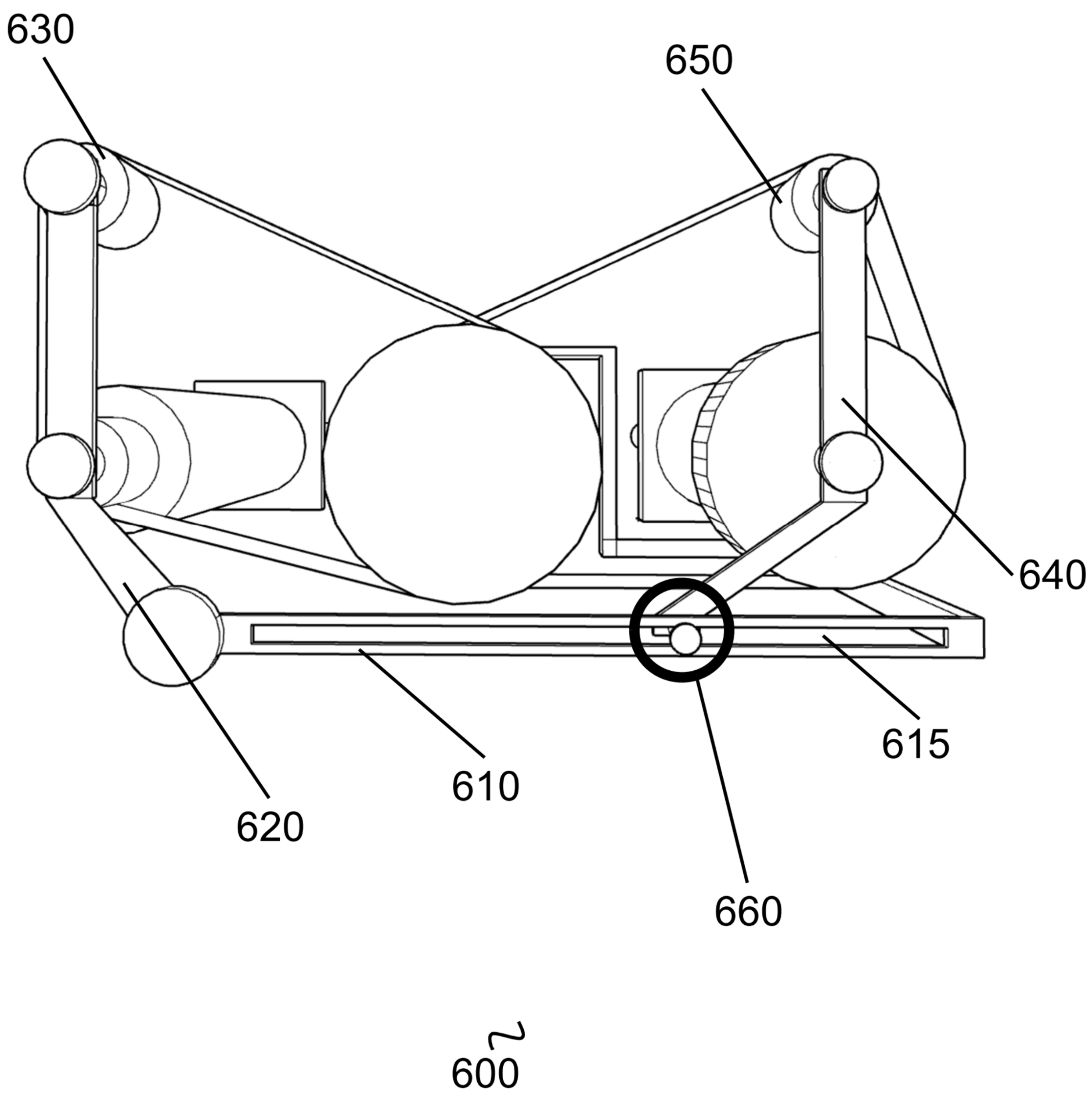


FIG. 7

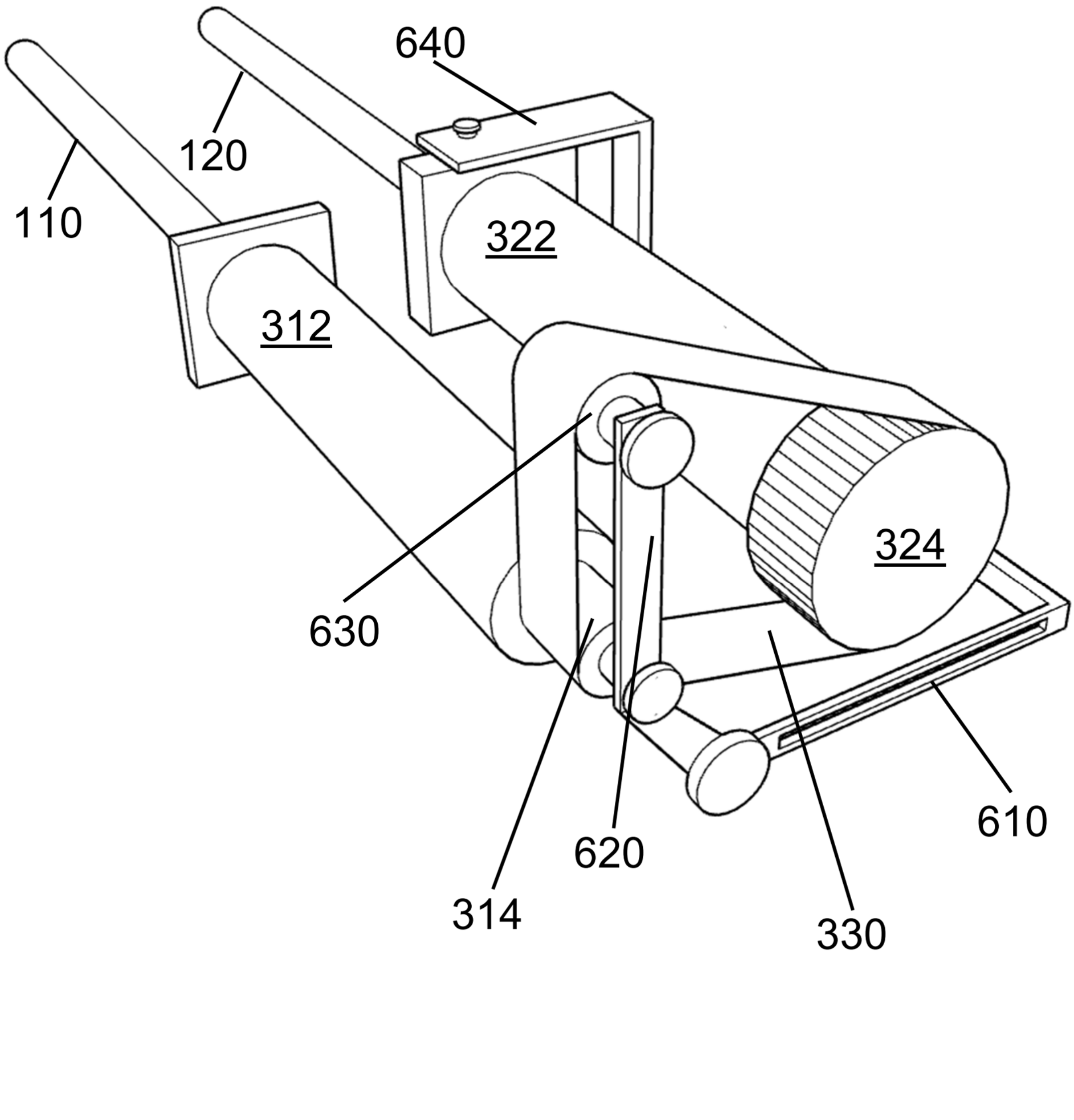
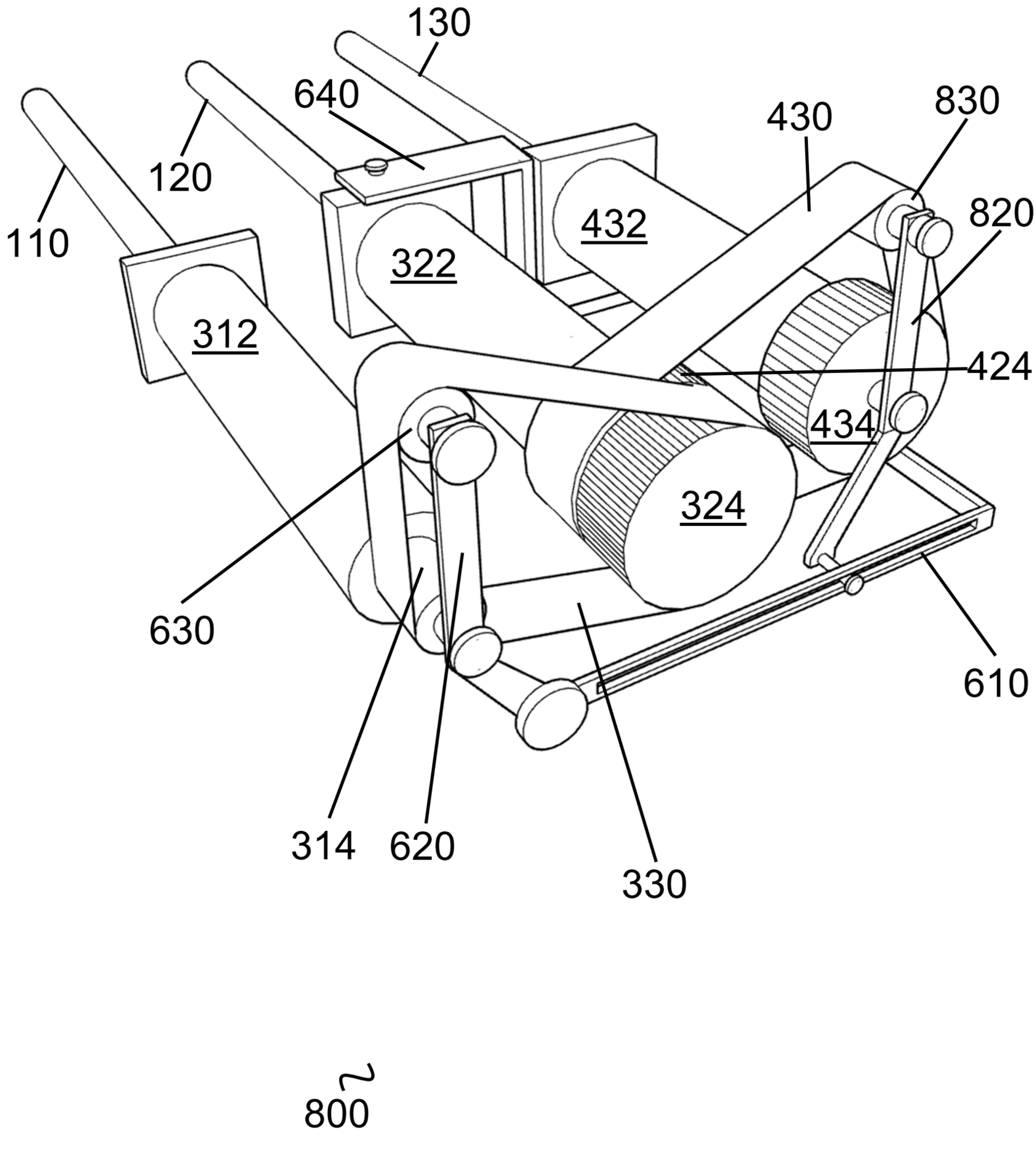


FIG. 8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EUROPEAN SEARCH REPORT

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Munich	26 March 2026	Todarello, Giovanni

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