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(54) APPARATUS FOR COMPACTING A CONTINUOUS TEXTILE SUBSTRATE BY MEANS OF AN ELASTIC BELT

(57) The invention relates to an apparatus for compacting a continuous textile substrate (T) by means of an elastic belt. The apparatus (1) comprises: a heatable rotating cylinder (10); an endless elastic belt (20); - a system of rollers (31, 32, 33, 34, 35) whereupon said belt (20) is wrapped in an elongation pretensioned state according to a predetermined pretensioning degree. The roller system comprises: - a set of three rollers consisting of a motorized drive roller (31), a motorized brake roller (32), and a first idle return roller (33), which is arranged between said motorized drive roller and said motorized brake roller; and - at least a second idle return roller (34). The motorized drive roller (31) and the motorized brake roller (32) are actuatable so as to cause said belt (20) to slide along said closed path by imposing upon said belt - according to a predetermined phase shifting degree of the respective tangential velocities - an additional elongation tension state. The motorized drive roller (31) is a metal roller, wherein the cylindrical side surface thereof, intended to come into contact with said belt (20), is smooth with a roughness chosen such as to generate, in contact with the elastic belt, a friction coefficient (f) which meets the following equation:

$$\frac{T2}{T1} \leq e^{f\alpha}$$

where α is the wrap angle of the belt around the drive roller (31), T1 is the belt tension downstream of the roller, and T2 is the belt tension upstream of the roller, wherein the ratio T2/T1 is a function of the predetermined pretensioning degree and the predetermined additional elongation tension state of the belt.

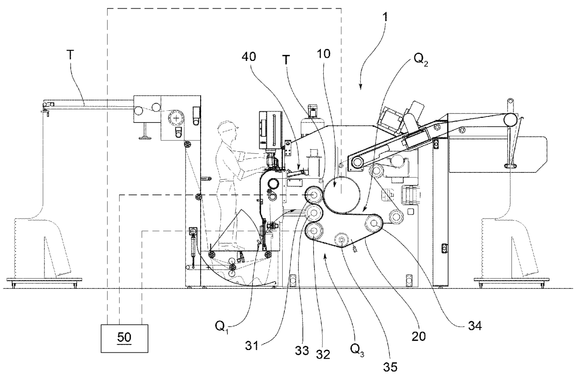

FIG.1

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Description

Field of application

[0001] The present invention refers to an apparatus for compacting a continuous textile substrate by means of an elastic belt.

Prior art

[0002] As is known, the process of compacting textiles or substrates is one of the main processes in the field of textile finishing and has the purpose of imparting stability to textiles before moving on to the packaging step.

[0003] Usually, stability and compaction to the texile is imparted using machines with established technology that make use of a change in the curvature of a felt or rubber belt on which is placed the texile to which impart compaction. The change in curvature of the support (felt or rubber belt) then imparts a longitudinal indent to the textile, which is then pressed against a hot cylinder, stabilizing the compacting effect and ensuring the dimensional stability of the textile once it leaves the machine.

[0004] All textiles (whether cross-woven or knitted), after being produced, require a stabilization and compaction process which makes them suitable for then being cut for packaging. Compacting machines are therefore widely used in finishing processes. The achievable compaction values depend upon the initial degree of stability of the textile produced. The initial degree of stability of a textile in turn depends upon the type of material from which it is made.

[0005] Frequently, it is necessary to carry out multiple passages of the same textile through compacting machines in order to obtain the desired compaction result. This happens in particular if the textile originally had a high degree of instability. All of this lengthens the processing time and affects production costs.

[0006] There is therefore a great need within the field to reduce the time required for textile compaction processes, especially in the case of textiles (e.g., made of viscose) which are characterized by high degrees of initial instability.

[0007] Over time, various alternative technical solutions have been proposed with the aim of making compacting systems more efficient. Such solutions have not however proved to be completely satisfactory.

[0008] More specifically, the textile compaction (or shortening) process is essentially performed by means of a so-called "compression" technique which is based upon the use of a substantially deformable belt whereto the textile to be compacted is tightly coupled. The deformation of the belt in the longitudinal forward direction, by mechanical means suitable for the purpose, consists substantially in the sequence of a first dilation step and a second contraction step. The textile, engaged integrally with the deformable surface of the belt, undergoes, in particular during the contraction step, "compression" in the forward direction, i.e., compaction of its structure and, ultimately, longitudinal contraction.

[0009] The deformability of the belt may be determined by the type and features of the material of which it is made and also by the type of mechanical stress exerted thereupon by mechanical means suitable for deforming said belt. Thus known are deformations by means of squeezing the belt thereby resulting in the dilation (elongation) thereof, followed by contraction (shortening) to the initial relaxed state; or deformations by means of varying the peripheral velocity of the belt, obtained by sliding it over rollers or cylinders with a different curvature radius with an alternately convex and concave path, which alternately cause an increase (elongation) and decrease (shortening) in peripheral velocity; or, finally, deformations by the longitudinal traction of the belt (elongation) followed by a release of the traction (shortening) to the initial relaxed state.

[0010] The patent GB 563 638 describes an apparatus for compacting textiles which proposes to improve the prior art by using an endless elastic belt supported and guided by rollers, wherein one thereof rotates at a variable velocity that is greater than the preceding roller. In this way, that portion of the belt between said two rollers is placed in an elongated state, whilst during the next step with the tension being relaxed, the belt is subjected to longitudinal contraction of a magnitude equal to the previous elongation.

[0011] The textile, coupled to the belt at the elongated portion thereof, follows it into the subsequent relaxed portion, partially wrapping around a rotating heated cylinder, also undergoing a corresponding longitudinal contraction or shortening.

[0012] This technique is not however without drawbacks, the first of which concerns the fact that the elastic belt is caused to rotate between the guide rollers in a completely and naturally relaxed state. Consequently, in the tension release segment, following that wherein the longitudinal traction is applied which causes it to elongate, the belt completely returns to the naturally relaxed state thereof, without maintaining any minimum residual tension that would allow it to effectively transport and guide the textile during the contraction step, nor to offer any control over the path thereof around the guide rollers thereof.

[0013] A further negative aspect is linked to the fact that the elastic belt, which is therefore extensible in length, when subjected to longitudinal traction also deforms transversely with a consequent and uncontrollable decrease in width. As the traction stress ceases, both dimensions of the belt tend to regain the original measurements thereof, i.e., it widens, and since, as mentioned, it has not maintained any minimum residual tension, the surface thereof tends to run loose and unextended, transmitting such irregularities to the textile that is coupled thereto.

[0014] The technical solution proposed in the European patent application EP1657340A1 partially overcomes the drawbacks described above.

[0015] More specifically, this solution provides for pretension traction to be applied to the elastic belt in such a way that it maintains a minimum residual tension at the end of the traction release step that caused the elongation thereof.

[0016] More specifically, the textile compacting apparatus described in EP1657340A1 comprises a heated rotating cylinder around which an elastic belt is partially wrapped. The elastic belt is moved by means of a plurality of motorized drive rollers and idle return rollers according to a predetermined closed path.

[0017] The roller apparatus is configured in such a way that by operating on the relative position of one of the rollers it is possible - during the step of mounting the belt onto the rollers - to pretension said belt with respect to the relaxed state thereof. During operations of the apparatus, with respect to such basic pretensioned state, the elastic belt is further tensioned by elongation before coming into contact with the cylinder. When the belt comes into contact with the textile in the wrapping segment around the cylinder, the belt is free to contract longitudinally, thereby drawing the textile therewith in a relative movement with respect to the cylinder. In this way, the textile is drawn by the longitudinal contraction movement of the elastic belt and is thus compacted longitudinally.

[0018] In particular, as shown in Figure 2 of EP1657340A1, the tensioning of the elastic belt (in addition to the pretensioned state) is implemented by means of the combined action of two sets of three rollers which are arranged in diametrically opposite positions with respect to the rotating cylinder. A first set of three rollers is positioned immediately upstream of the heated cylinder (upstream of the first point of contact of the belt with the cylinder), while a second set of three rollers is positioned downstream of the cylinder (downstream of the point of detachment of the belt from the cylinder). An idle return roller is arranged between the two sets of three rollers within the segment of the path of the elastic belt opposite to that which is in contact with the cylinder. The rollers of the first set of three rollers are all motorized and rotate at the same first tangential velocity, with alternating directions of rotation. In the second set of three rollers, the first rollers that the belt encounters are motorized and rotate at the same second tangential velocity, with alternating directions of rotation. The third roller of the second set is, on the other hand, idle.

[0019] Operatively, the elastic belt is elastically elongated throughout the path segment opposite to the wrapping segment around the cylinder, differentiating the tangential velocities that the two sets of three rollers impose upon the elastic belt. In particular, the first tangential velocity (i.e., imposed by the first set of three rollers) is higher than the second tangential velocity (i.e., imposed by the second set of three rollers) by a value of between 20% and 60%.

[0020] The compacting apparatus described above improves the compaction process by virtue of the pretensioning of the belt, but the results obtained are not completely satisfactory. In fact, the compacting apparatus described above does not allow for precise control of the elongation of the elastic belt and therefore of the degree of tensioning imposed upon said belt. In particular, the roller movement apparatus does not allow for the complete elimination of slippages of the elastic belt with respect to the guide rollers. This negatively affects the efficiency of the compaction process.

[0021] The problem of the elastic belt slipping on the guide rollers has been addressed in many ways, on the assumption that a guide roller made from a smooth steel cylinder is not able to generate sufficient friction to prevent the belt from slipping.

[0022] This problem has been addressed by creating grooves or knurling on the surface of the guide rollers, as described for example in US2374482. This solution, if on the one hand allows the slippages of the belt on the guide rollers to be reduced to zero, on the other hand, it introduces problems of premature wearing of the belt due to the abrasive action exerted by the rollers upon said belt.

[0023] In view of these issues, the belt slippage problem has been solved by coating the guide rollers with a layer of rubber. This strategy, well known in the field of conveyor belts, allows the friction between the belt and the guide roller to be significantly increased, while at the same time counteracting abrasive phenomena on said belt. This strategy is described, for example, in WO2020/183410A1 and WO2020/178670A1.

[0024] Rubberizing the guide rollers, however, entails an increase in the production costs of said rollers compared to traditional rollers. The rubberized coating must, in fact, be applied to the steel roller in respecting specific tolerances and in such a way as to ensure the long-lasting adhesion thereof.

[0025] In the field of compacting machines there is therefore the need - not yet met - to reduce guide roller production costs without affecting the functionality thereof in terms of the ability to prevent the belt from slipping.

Disclosure of the invention

[0026] The object of the present invention is to therefore eliminate in whole or in part the drawbacks of the aforementioned prior art in providing an apparatus for compacting textiles by means of an elastic belt which allows the belt to avoid slipping with respect to the guide rollers without requiring the rubberized coating of at least one of the guide rollers.

[0027] A further object of the present invention is to provide an apparatus for compacting textiles by means of an elastic belt which is simple and cost-effective to manufacture.

[0028] A further object of the present invention is to provide an apparatus for compacting textiles by means of an elastic belt which is manageable in an operatively simple manner.

Brief description of the drawings

[0029] The technical features of the invention, according to the aforesaid objects, may be clearly seen in the contents of the claims below, and its advantages will become more readily apparent in the detailed description that follows, made with reference to the accompanying drawings, which represent one or more purely exemplifying and non-limiting embodiments thereof, wherein:

- Figure 1 is a schematic view of an apparatus for compacting textiles by means of an elastic belt according to a preferred embodiment of the present invention, shown with a first configuration of the guide rollers of the belt;
- Figure 2 is an enlarged view of a detail of the diagram of Figure 1 relating to the area of passage of the elastic belt in the guide rollers;
- Figure 3 is a schematic view of the apparatus for compacting textiles by means of an elastic belt of Figure 1, shown with a second configuration of the guide rollers of the belt;
- Figure 4 is an enlarged view of a detail of the diagram of Figure 3 relating to the area of passage of the elastic belt in the guide rollers; and
  Figure 5 is a graph relating to the progression of the tension on an elastic belt as a function of the elongation thereof.

Detailed description

[0030] With reference to the accompanying drawings, an apparatus for compacting a continuous textile substrate by means of an elastic belt according to the invention has been indicated in the entirety thereof with the numeral 1.

[0031] Advantageously, the textile substrate T may be of any type; in particular it may be a cross-woven (shuttle) textile or a knitted textile. The textile substrate may consist of any type of fiber used for shuttle and knitted textiles.

[0032] As shown schematically in Figure 1, the compacting apparatus 1 comprises:

- a heatable rotating cylinder 10;
- an endless belt 20 which is elastically deformable in elongation and is movable along a closed path to support and transport a textile substrate T in contact with a side surface portion 10a of said heatable rotating cylinder 10;
- a system of rollers 31, 32, 33, 34, 35 whereupon the belt 20 is wrapped in an elongated pretensioned state according to a predetermined pretensioning degree.

[0033] In turn, such a roller system comprises:

- a set of three rollers consisting of a motorized drive roller 31, a motorized brake roller 32, and a first idle return roller 33, which is arranged between said motorized drive roller and said motorized brake roller; and
- at least a second idle return roller 34.

[0034] The motorized drive roller 31 and the motorized brake roller 32 are actuatable so as to slide said belt 20 along said closed path, imposing on said belt - according to a predetermined phase shifting degree of the respective tangential velocities - an additional elongation tension state at a first segment Q1 of said path, wherein the belt passes through the set of three rollers 31, 32 and 33, wrapping at least partially each of the three rollers.

[0035] Advantageously, said motorized drive roller 31, said motorized brake roller 32, and said first idle return roller 33 are mutually positioned so that the wrap angle α of said belt 20 around said motorized drive roller 31 and the wrap angle β of said belt 20 around said motorized brake roller 32 are not less than 90°.

[0036] Preferably, the wrap angle of said belt 20 around said drive roller 31 is not less than 120°.

[0037] As shown schematically in Figure 2 and 4, the belt is installed on the set of three rollers so as to follow an S-shaped path through the three rollers. In particular, the two motorized drive rollers 31 and 32 contact the belt on the inner surface thereof, while the first idle return roller 33 contacts the belt on the outer surface thereof. The first idle return roller 33, interposed between the two motorized rollers 31 and 32, may thus thrust the belt against them, facilitating the wrapping of the belt. The "thrust" action of the return roller and therefore the effect in terms of wrapping may be calibrated by operating on the nominal diameters of the rollers and/or on the relative position of the centers of rotation.

[0038] Operatively, the higher the wrap angle of the belt on the drive roller 31 and on the brake roller 32, the greater the friction that is generated between the motorized rollers and the belt and therefore the more efficient the driving action of the rollers on the belt, with a reduction of slippage phenomena between the roller and the belt.

[0039] As will be clarified below, all of this helps to improve the control over the elongation action of the belt and therefore to increase the efficiency of the process of compacting the textile substrate.

[0040] The first path segment Q1 extends - with respect to a forward direction X of the belt - upstream of a second segment Q2 of said path wherein said belt 20 is kept in contact with the rotating cylinder.

[0041] The second path segment Q2 extends between said motorized drive roller 31 and said second idle return roller 34.

[0042] The closed path is completed by a third segment Q3 which extends between said second idle return roller 34 and said motorized brake roller 32.

[0043] The compacting apparatus 1 further comprises means 40 for guiding a textile substrate T between the belt 20 and the heatable cylinder 10 along the second segment Q2 of such closed path.

[0044] Operatively, the compacting action on the textile substrate T takes place along the aforesaid second segment Q2 of the closed path. At this second segment Q2 the elastic belt contracts elastically and passes from the additional elongation tension state, which has been imposed upstream in the first segment Q1, to a state close to that of pretensioning. The textile substrate T, which in the second segment Q2, due to frictional forces, moves integrally with the belt 20, undergoes the contraction of the belt itself, and in turn contracts longitudinally thereby compacting itself.

[0045] With reference to the forward direction X of the belt 20 along the closed path, the motorized drive roller 31 is the roller placed immediately upstream of the heatable cylinder 10, while the second idle return roller 34 is the roller placed immediately downstream of the heatable cylinder 10.

[0046] The "closed path" corresponds to the total extension of the belt 20 when mounted pretensioned on the roller system. The closed path is not modified by the local contractions and elongations of the belt.

[0047] According to the invention, the motorized drive roller 31 is a metal roller, the cylindrical side surface of which, intended to come into contact with said belt 20, is smooth with a roughness selected so as to generate, in contact with the elastic belt, a friction coefficient f which satisfies the following equation:

$$\frac{T2}{T1} \leq e^{f\alpha}$$

where:

- α is the wrap angle of the belt around the drive roller 31;
- T1 is the belt tension downstream of the roller 31; and
- T2 is the belt tension upstream of the roller.

[0048] The ratio T2/T1 is a function of the predetermined pretensioning degree and the predetermined additional elongation tension state of the belt.

[0049] By approximating the belt 20 to a flat belt, according to the theory of flat belts, with the values T1 and T2 of the tensions applied to the belt and the wrap angle α known, the values of the friction coefficient f that meet the aforesaid equation are such as to ensure that the belt does not slip on the roller.

[0050] The wrap angle α of the belt around the drive roller 31 is a dimensioning parameter of the compacting apparatus 1 and is therefore known. In particular, the wrap angle α is fixed according to the arrangement of the set of three rollers 31, 32 and 33 dictated by the available space.

[0051] The values of the tensions T2 and T1 depend upon the pretension that is given to the belt and on the phase shifting of the tangential velocities of the drive roller and of the brake roller set during operation (additional elongation tension state of the belt).

[0052] T2 and T1 also depend upon the type of rubber of the belt and upon the section thereof. The values of T1 and T2 should therefore be studied on a case-by-case basis.

[0053] That which is relevant, however, is the ratio between T2 and T1.

[0054] The ratio between T2 and T1 is independent of the type of rubber used in the belt and the section thereof and, as mentioned above, it depends instead upon the pretension applied to the belt and upon the phase shifting conditions during operation.

[0055] That which is of interest is that the ratio T2/T1 must be below a threshold (e^{fa}) which depends upon the wrap angle (α) and the friction coefficient (f). This is the condition that allows the belt to not slip and to therefore engage with the textile.

[0056] In particular, the tensions T1 and T2 may be calculated by multiplying the elongation of the belt by the elastic constant, assuming that the belt behaves like a spring:

$$F=K*x$$

where K is the elastic constant, x is the elongation and F is the force.

[0057] The elastic constant K of a belt may be calculated empirically by lengthening the belt and measuring the effort required to lengthen it. Figure 5 shows the data of the measurements made for a belt with a thickness of 12 mm and width of 3000 mm.

[0058] Example calculation: using the graph in Figure 5, an elongation of 80% corresponds to a force of about 23,700 N. The elongation takes into account both the pretension and the phase shift. The calculation of T1 and T2 it is therefore easy, known the elongation.

[0059] The tensions T1 and T2 and the wrap angle α being known, the ideal friction coefficient f is calculated.

[0060] By calculating the friction coefficient F by means of experimental tests, the roughness of the side surface of the smooth metal roller is established, which makes it possible to obtain, using a predetermined belt, friction coefficient values that are close to the calculated ideal one.

[0061] It should be noted that the friction coefficient is an empirical datum measured between the surfaces and is always obtained experimentally.

[0062] By virtue of the invention, contrary to that which is known in the prior art, it is possible to avoid belt slipping on the drive roller without equipping the surface of the roller with knurlings and/or grooves and without coating said roller with rubber.

[0063] By virtue of the invention it is in fact possible to use as a drive roller a smooth steel roller having a roughness chosen so as to generate using the belt a friction coefficient calculated as expressed above.

[0064] In this way, the following advantages are obtained:

- the production of the drive roller is simplified (absence of rubber on the roller);
- abrasive phenomena are reduced due to the fact that the friction coefficients are not oversized, but may be chosen so as to ensure minimum friction in order to prevent slippage.

[0065] Operatively, obtaining a correct friction coefficient reduces the risk of slippage between the belt and the rollers. This helps to improve the control over the elongation action of the belt and therefore increases the efficiency of the process of compacting the textile substrate.

[0066] As may be seen by comparing Figure 2 and Figure 4, the compacting apparatus 1 may assume different configurations regarding the wrap angle of the belt around the heatable rotating cylinder 10 in varying the position of the second idle return roller 34. In particular, in the configuration of Figure 2 the wrap angle around the heated cylinder is about 90°, while in Figure 4 it is about 180°.

[0067] From that which is expressed above, the wrap angle γ of the belt around the heatable rotating cylinder 10 is per se irrelevant to the slipping of the belt on the drive cylinder 31. Thus, the choice of the material and surface finish of the drive roller is not important insofar as the belt wraps around the heated cylinder. Only the tension state of the belt (pretension of the belt and maximum phase shift between the drive and brake rollers) and the wrap angle on the drive roller matter.

[0068] It is therefore possible to vary the wrap angle of the belt around the heated cylinder 10 according to the operational requirements of contact between the belt and the heated cylinder without affecting the slipping of the belt on the roller, provided that the tension state of the belt is maintained. Operatively, if instead the variation of the wrap angle leads to a variation of the tension state, effects on the slipping between the belt and the roller occur.

[0069] A reduction in the wrap angle of the belt around the heated cylinder 10 makes it possible to reduce wear to the belt (less slipping in the side areas not covered by the textile) and to reduce the negative effects on said textile (waves and folds due to a change in friction within the lateral areas).

[0070] In the case of Figure 2, the wrap angle around the heated cylinder is 180°. The following values have been considered: wrap angle α around the drive roller equal to 180°; wrap angle around the brake roller equal to 90°. The pretensioning of the belt is 45%. Under these conditions the required friction coefficient f between the drive cylinder and the belt must be greater than 0.34; the required friction coefficient between the brake cylinder and the belt must be greater than 0.68.

[0071] In the case of Figure 4, the wrap angle around the heated cylinder is 90°. The following values have been considered: wrap angle α around the drive roller equal to 180°; wrap angle around the brake roller equal to 90°. The belt pretensioning is 31%. Under these conditions the required friction coefficient f between the drive cylinder and the belt must be greater than 0.42; the required friction coefficient between the brake cylinder and the belt must be greater than 0.85.

[0072] From the foregoing, it emerges that if the pretensioning of the belt is reduced, the life of the belt increases, but on the other hand the minimum value of the required friction coefficients increases.

[0073] Preferably, the motorized drive 31 and brake rollers 32, the idle return rollers 33, 34, 35, as well as the heatable cylinder 10 are made of metal, preferably steel.

[0074] According to a particularly preferred embodiment of the invention, as shown in the accompanying figures, the motorized brake roller 32 is provided with a rubber coating 36 which covers the cylindrical side surface intended to come into contact with the belt 20. In fact, it has been possible to verify that due to the reduced wrap angle β of the belt on the brake roller 32 the friction coefficient is such as to require extreme roughness which would induce intense abrasive phenomena on the belt.

[0075] Preferably, both the first idle return roller 33 and the second idle return roller 34 are not rubberized. In other words, both the first idle return roller 33 and the second idle return roller 34 are provided with a cylindrical side surface, preferably made of a metal material, intended to come into direct contact with the belt 20 without the interposition of a rubber coating covering said cylindrical side surface.

[0076] Operatively, by virtue of the fact that the idle return rollers 33 and 34 are not rubberized and the elastic belt 20 comes into direct contact with the metal side surface thereof, the friction between the belt and the idle rollers is reduced. In this case, the roughness of the smooth surfaces of these rollers is chosen so as to minimize the friction coefficient. In this way, by virtue of the reduction of friction, the belt encounters fewer obstacles in its elastic extension and in its subsequent contraction.

[0077] Operatively, the additional elongation tension state is imposed on the belt 20 by acting on the velocities of the motorized drive roller 31 and of the motorized brake roller 32 so as to create a difference between the tangential velocities of the side surfaces of the two rollers (intended to come into contact with the belt). The elongation tension state (measurable, for example, in an elongation percentage with respect to the pretensioned state) increases as the difference in these velocities increases.

[0078] Advantageously, the apparatus 1 may comprise a control unit 50, preferably electronic, configured to control the rotation of the motorized drive roller 31 and the motorized brake roller 32 so that said two motorized rollers 31, 32 rotate in the same direction and so that the tangential velocity Vt of the motorized drive roller 31 is higher than the tangential velocity Vf of the motorized brake roller 32 according to a predetermined ratio Vf/Vt.

[0079] Advantageously, this predetermined ratio Vf/Vt between the tangential velocity of the motorized brake roller 32 and the tangential velocity of said motorized drive roller 31 is adjustable as a function of the amount of longitudinal elongation to be imposed on the belt at the first path segment Q1.

[0080] Preferably, said predetermined ratio Vf/Vt is between 0.5 and 0.9, and preferably equal to 0.7.

[0081] Preferably, the heatable rotating cylinder 10 is motorized. The term "heatable cylinder" refers in particular to a cylinder equipped with or coupled to heating means. The heating means may be of any type suitable for the purpose, i.e., heating the surface of the rotating cylinder.

[0082] Advantageously, the control unit 50 is configured to control the rotation of the heatable cylinder so that the tangential velocity thereof (referred to the side surface 10a) is as close as possible to the tangential velocity of the motorized drive roller 31, and preferably equal thereto.

[0083] It has been possible to verify that under these conditions the best results are obtained in terms of compacting the textile substrate. In other words, under these conditions the efficiency of the compaction process is increased.

[0084] Preferably, the motorized drive roller 31, the motorized brake roller 32, and the first idle return roller 33 are mutually positioned so that the aforementioned first segment Q1 of the closed path has an extension in length not greater than 35% of the entire closed path, and preferably, not less than 10%.

[0085] Advantageously, as schematically shown in particular in Figures 2 and 4, the motorized drive roller 31, the motorized brake roller 32, and the first idle return roller 33 are arranged relative to each other so as to assume a compact configuration. The term "compact configuration" refers to a configuration wherein said three rollers 31, 32, and 33 are arranged closely therebetween when compared with the other rollers 34 and 35 of the roller system.

[0086] The "compact configuration" is essentially aimed at reducing as much as possible the extension of the first segment Q1 of the path in favor of the third segment Q3 of the path.

[0087] In particular, said three rollers 31, 32, and 33 may be arranged to form a set of three rollers with aligned centers of rotation. This choice is preferred from a construction point of view insofar as it allows for a reduction in the overall dimensions and simplifies the support structure of said rollers. However, configurations of the set of three rollers may be provided wherein the rollers are not aligned therebetween.

[0088] As already highlighted above, with reference to the forward direction X of the belt 20 along the closed path, the motorized drive roller 31 is the roller placed immediately upstream of the heatable cylinder 10, while the second idle return roller 34 is the roller placed immediately downstream of the heatable cylinder 10.

[0089] The motorized drive roller 31 and the second idle return roller 34 are preferably positioned with respect to the cylinder 10 such that:

- the distance D1 between the side surface 31a of the motorized drive roller 31 and the side surface 10a of the cylinder 10 is equal to or less than the thickness S of the belt 20; and
- the distance D2 between the side surface 10a of the cylinder 10 and the side surface 34a of the second idle return roller 34 is equal to or greater than the thickness S of the belt 20.

[0090] Preferably, the aforesaid distance D1 is less than the thickness S of the belt 20 by a value ranging between about 0% and about 50%; the aforesaid distance D2 is greater than the thickness S of the belt 20 by a value between about 0% and about 100%.

[0091] Advantageously, the aforesaid second idle return roller 34 is movable with respect to the other rollers 31, 32, 33 in order to vary the relative position thereof and allow for:

- the mounting and dismounting of the belt on said roller system;
- belt maintenance operations; and
- the pretensioning of the belt 20.

[0092] According to a particularly preferred embodiment, the second idle return roller 34 is movable with respect to the other rollers 31, 32, 33 along a circumferential arc, concentric to the rotation axis of the cylinder 10, between a maximum wrap position of the belt around the cylinder and a minimum wrap position around the cylinder.

[0093] For this purpose, the second idle return roller 34 is slidably engaged at both of the axial ends thereof with a guide (not shown in the accompanying figures) shaped according to said circumferential arc.

[0094] Advantageously, the second idle return roller 34 is lockable both in the aforesaid two extreme positions of the aforesaid circumferential arc and in one or more intermediate positions, so as to adjust the extension of said second segment Q2 of the closed path and thus the degree of wrapping of the belt around the cylinder 10. In this way it is possible to calibrate the compacting effect on the textile substrate based upon the demands dictated by the type of fiber and the result to be obtained. In this way, the friction effect of the belt on the hot cylinder may also be improved and decreased precisely due to the decrease in wrap angle. This has a benefit on the result of the compaction process.

[0095] The locking of the second idle return roller 34 along the aforesaid shaped guide may be achieved by brackets which also include bearings adapted to rotate the roller pin and which are fixable, for example by screws, to the support structure of the apparatus. In particular, the fixing of the roller is performed at shoulders suitably perforated in advance along said guide in predetermined angular positions corresponding to the adjustment positions to be provided.

[0096] Preferably, the circumferential arc has an extension of 90°. Circumferential arcs of a smaller or lower amplitude according to operational needs may be provided.

[0097] Adjusting the position of the second idle return roller 34 relative to the cylinder 10 may change the tensioning state of the belt.

[0098] Preferably, as shown in Figure 1, the apparatus 1 comprises a third idle return roller 35 which engages the belt at the third segment Q3 of the path and is movable with respect to the other rollers 31, 32, 33 in order to compensate for variations in the position of the second idle return roller 34.

[0099] Similarly to that which is provided for the second idle return roller 34, the third idle return roller 35 is also slidably engaged at both of the axial ends thereof with a suitably shaped guide (not shown in the accompanying figures). The third idle roller 35 may also be fixed and stopped in intermediate positions between two positions of maximum and minimum compensation. The fixing may be achieved by means of brackets that include roller bearings and that will be fastened using screws to the shoulders of the apparatus, suitably perforated at the predetermined positions.

[0100] Preferably, as with the first and second idle return rollers 33 and 34, the third idle return roller 35 is also not rubberized. In other words, the third idle return roller 35 is also provided with a cylindrical side surface, preferably made of a metal material, intended to come into direct contact with the belt 20 without the interposition of a rubber coating covering said cylindrical side surface.

[0101] Operatively, as already highlighted in relation to the idle return rollers 33 and 34, also for the third idle return roller 35, by virtue of the absence of rubber and therefore the fact that the elastic belt 20 comes into direct contact with the metal side surface of said third idle roller 35 the friction between the belt and the idle roller is reduced. In this way, by virtue of the reduction in friction, the belt encounters fewer obstacles as regards the sliding thereof, avoiding localized tensions due to friction.

[0102] Preferably, the aforesaid belt 10 is elastically deformable in elongation by a percentage of between 5% and 100% of the length thereof in the relaxed state before pretensioning and, preferably in the pretensioned state thereof, by a percentage of between 30% and 50% with respect to the relaxed length thereof.

[0103] Preferably, the belt 20 has a thickness S of between about 4.0 mm and about 16.0 mm and, preferably, about 10 mm.

[0104] The belt 20 may be made of a substantially extensible and elastic material, in particular of natural or synthetic rubber, or combinations thereof. Advantageously, the material may contain additives adapted to improve the mechanical and heat resistance features thereof.

[0105] The invention allows numerous advantages to be obtained, which have already been described in part.

[0106] The apparatus for compacting textile substrates by means of an elastic belt according to the invention makes it possible to avoid slippages of the belt with respect to the guide rollers without requiring the rubberized coating of at least one of the guide rollers.

[0107] The apparatus for compacting textile substrates by means of an elastic belt according to the invention is simple and inexpensive to implement.

[0108] The apparatus for compacting textile substrates by means of an elastic belt according to the invention is manageable in an operatively simple manner.

[0109] The apparatus for compacting textile substrates by means of an elastic belt according to the invention makes it possible to reduce the stresses imposed on the elastic belt during use.

[0110] Further advantages obtainable with the compacting apparatus according to the invention are listed below:

- High elongation precision of the belt;
- Ensuring perfect driving of the belt without any slippage thereof on the drive and brake rollers by virtue of the wide wrap angle thereupon (given by the interposed idle roller).

[0111] Obviously, in practice it may also assume different forms and configurations from the one illustrated above, without thereby departing from the present scope of protection.

[0112] Furthermore, all details may be replaced with technically equivalent elements, and the dimensions, shapes, and materials used may be any according to the needs.

Claims

1. An apparatus for compacting a continuous textile substrate (T) by means of an elastic belt, comprising:

- a heatable rotating cylinder (10);
- an endless elastic belt (20) movable along a closed path to support and transport the textile substrate (T) in contact with a side surface portion (10a) of said heatable rotating cylinder (10), said belt being elastically deformable in elongation;
- a roller system (31, 32, 33, 34, 35) whereupon said belt (20) is wrapped in a pretensioning state in elongation according to a predetermined pretensioning degree,
- means (40) for guiding said textile substrate (T) between said belt (20) and said heatable cylinder (10), wherein said roller system comprises:

- a set of three rollers consisting of a motorized drive roller (31), a motorized brake roller (32), and a first idle return roller (33), which is arranged between said motorized drive roller and said motorized brake roller; and
- at least a second idle return roller (34),

the motorized drive roller (31) and the motorized brake roller (32) being actuatable so as to cause said belt (20) to slide along said closed path by imposing on said belt - according to a predetermined phase shifting degree of the respective tangential velocities - an additional elongation tension state at a first segment (Q1) of said path in which the belt passes through the set of three rollers (31, 32 and 33) at least partially wrapping each of the three rollers,
the first path segment (Q1) extending - with respect to a forward direction (X) of the belt - upstream of a second segment (Q2) of said path in which said belt (20) is kept in contact with the rotating cylinder, said second path segment (Q2) extending between said motorized drive roller (31) and said second idle return roller (34), said closed path being completed by a third segment (Q3) extending between said second idle return roller (34) and said motorized brake roller (32),
characterized in that the motorized drive roller (31) is a metal roller the cylindrical side surface of which, intended to come into contact with said belt (20), is smooth with a roughness chosen so as to generate, in contact with the elastic belt, a friction coefficient (f) which meets the following equation:

$$\frac{T2}{T1} \leq e^{f\alpha}$$

where α is the wrap angle of the belt around the drive roller (31), T1 is the belt tension downstream of the roller, and T2 is the belt tension upstream of the roller, wherein the ratio T2/T1 is a function of the predetermined pretensioning degree and the predetermined additional elongation tension state of the belt.

2. An apparatus according to claim 1, in which said motorized brake roller (32) is provided with a rubber coating, which covers the cylindrical side surface of the roller itself, intended to come into contact with said belt (20).

3. An apparatus according to claim 1 or 2, wherein said first idle return roller (33) is provided with a cylindrical side surface made of metal material, intended to come into direct contact with said belt (20) without the interposition of a rubber coating covering such a cylindrical side surface.

4. An apparatus according to claim 1, 2 or 3, wherein said second idle return roller (34) is provided with a cylindrical side surface made of metal material, intended to come into direct contact with said belt (20) without the interposition of a rubber coating covering such a cylindrical side surface.

5. An apparatus according to one or more of the preceding claims, wherein said motorized drive roller (31), said motorized brake roller (32), and said first idle return roller (33) are mutually positioned so that the wrap angle of said belt (20) around said motorized drive roller (31) and said motorized brake roller (32) is not less than 90°.

6. An apparatus according to claim 5, wherein the wrap angle of said belt (20) around said motorized drive roller (31) is not less than 120°.

7. An apparatus according to one or more of the preceding claims, comprising a control unit (50) configured to control the rotation of said motorized drive roller (31) and said motorized brake roller (32) so that said two motorized rollers (31, 32) rotate in the same direction and so that the tangential velocity (Vt) of said motorized drive roller (31) is greater than the tangential velocity (Vf) of said motorized brake roller (32) according to a predetermined ratio (Vf/Vt).

8. An apparatus according to claim 7, wherein said predetermined ratio (Vf/Vt) between the tangential velocity of said motorized brake roller (32) and the tangential velocity of said motorized drive roller (31) is adjustable as a function of the amount of longitudinal elongation to be imposed on said belt at said first path segment (Q1).

9. An apparatus according to claim 8, wherein said predetermined ratio (Vf/Vt) is between 0.5 and 0.9, and preferably equal to 0.7.

10. An apparatus according to one or more of the preceding claims, wherein said heatable cylinder (10) is motorized.

11. An apparatus according to claim 10 when dependent on claim 7, 8 or 9, wherein said control unit (50) is configured to control the rotation of said heatable cylinder (10) so that the tangential velocity thereof - referred to the side surface (10a) thereof - is as close as possible to the tangential velocity of the motorized drive roller (31), and preferably equal thereto.

12. An apparatus according to one or more of the preceding claims, wherein said second idle return roller (34) is movable with respect to the other rollers (31, 32, 33) to change the relative position thereof and allow said belt (20) to be assembled and pretensioned on said roller system.

13. An apparatus according to one or more of the preceding claims, wherein said second idle return roller (34) is movable with respect to the other rollers (31, 32, 33) along a circumferential arc concentric to the rotation axis of the cylinder (10) between a maximum wrap position of the belt around said cylinder and a minimum wrap position of the belt around said cylinder and is lockable in one or more intermediate positions between said two positions in order to adjust the extension of said second segment (Q2) of the closed path,
and wherein said apparatus (1) comprises a third idle return roller (35) engaging said belt at said third path segment (Q3) and is movable with respect to the other rollers (31, 32, 33) to compensate for changes in the position of said second idle return roller (34) and thus maintain the pretensioning of said belt.

14. An apparatus according to claim 13, wherein said third idle return roller (35) is provided with a cylindrical side surface made of metal material, intended to come into direct contact with said belt (20) without the interposition of a rubber coating covering such a cylindrical side surface.

15. An apparatus according to one or more of the preceding claims, wherein said belt (10) is elastically deformable in elongation by a percentage between 5% and 100% of the length thereof in the relaxed state before pretensioning, and preferably in the pretensioned state thereof, by a percentage between 30% and 50% with respect to the relaxed length thereof.

16. An apparatus according to one or more of the preceding claims, wherein a distance (D1) between the side surface (31a) of the motorized drive roller (31) and the side surface (10a) of the cylinder (10) is equal to or less than the thickness (S) of the belt (20), and wherein a distance (D2) between the side surface (10a) of the cylinder (10) and the side surface (34a) of the second idle return roller (34) is equal to or greater than the thickness (S) of the belt (20).

17. An apparatus according to claim 16, wherein the distance (D1) between the side surface (31a) of the motorized drive roller (31) and the side surface (10a) of the cylinder (10) is less than the thickness (S) of the belt (20) by a value between about 0% and about 50%, and wherein the distance (D2) between the side surface (10a) of the cylinder (10) and the side surface (34a) of the second idle return roller (34) is greater than the thickness (S) of the belt (20) by a value between about 0% and about 100%.

18. An apparatus according to one or more of the preceding claims, wherein the belt (20) has a thickness (S) between about 4.0 mm and about 16.0 mm, and preferably of about 10 mm.

19. An apparatus according to one or more of the preceding claims, wherein the belt (20) is made of natural or synthetic rubber or a combination of natural and synthetic rubber.

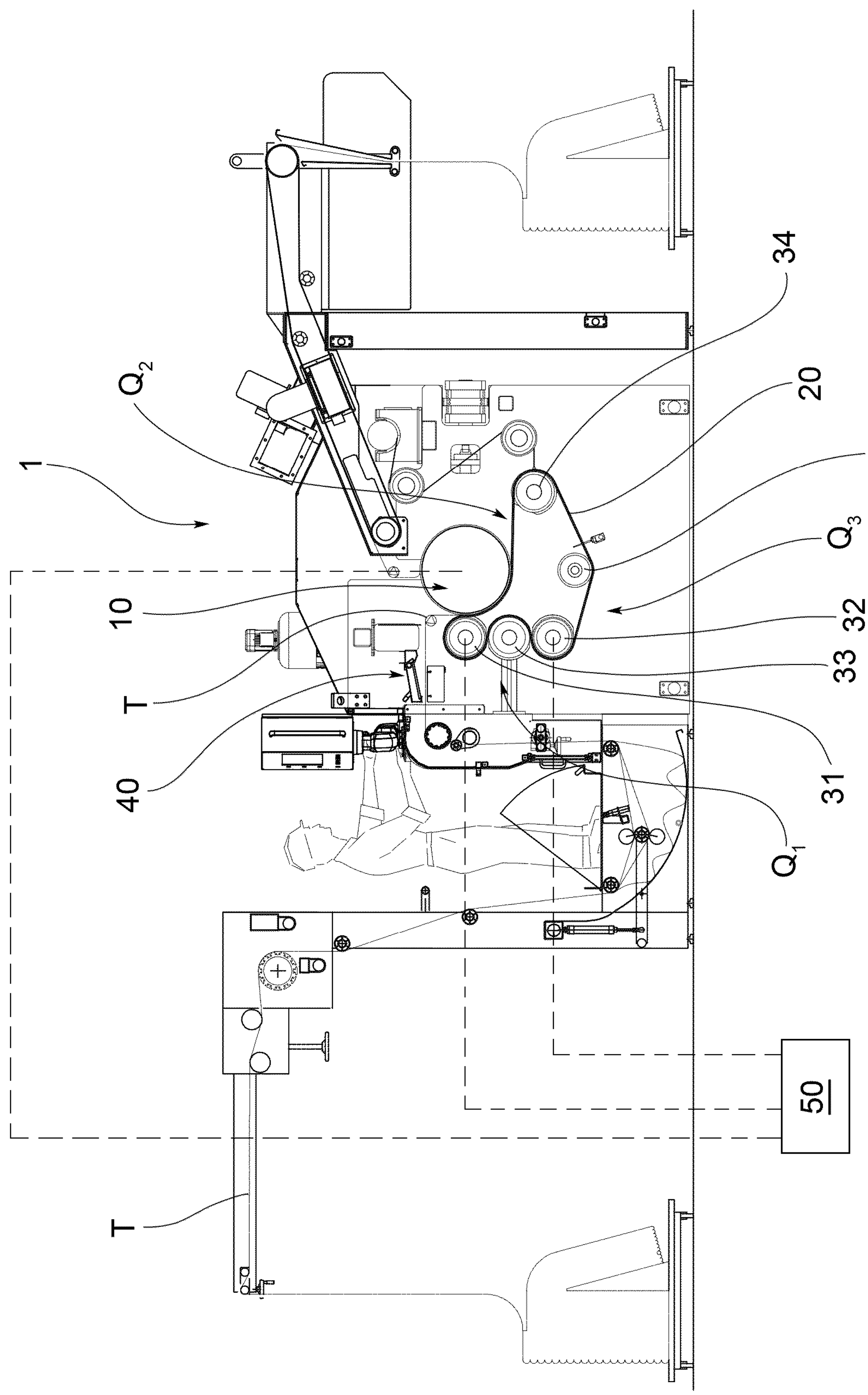


FIG.1

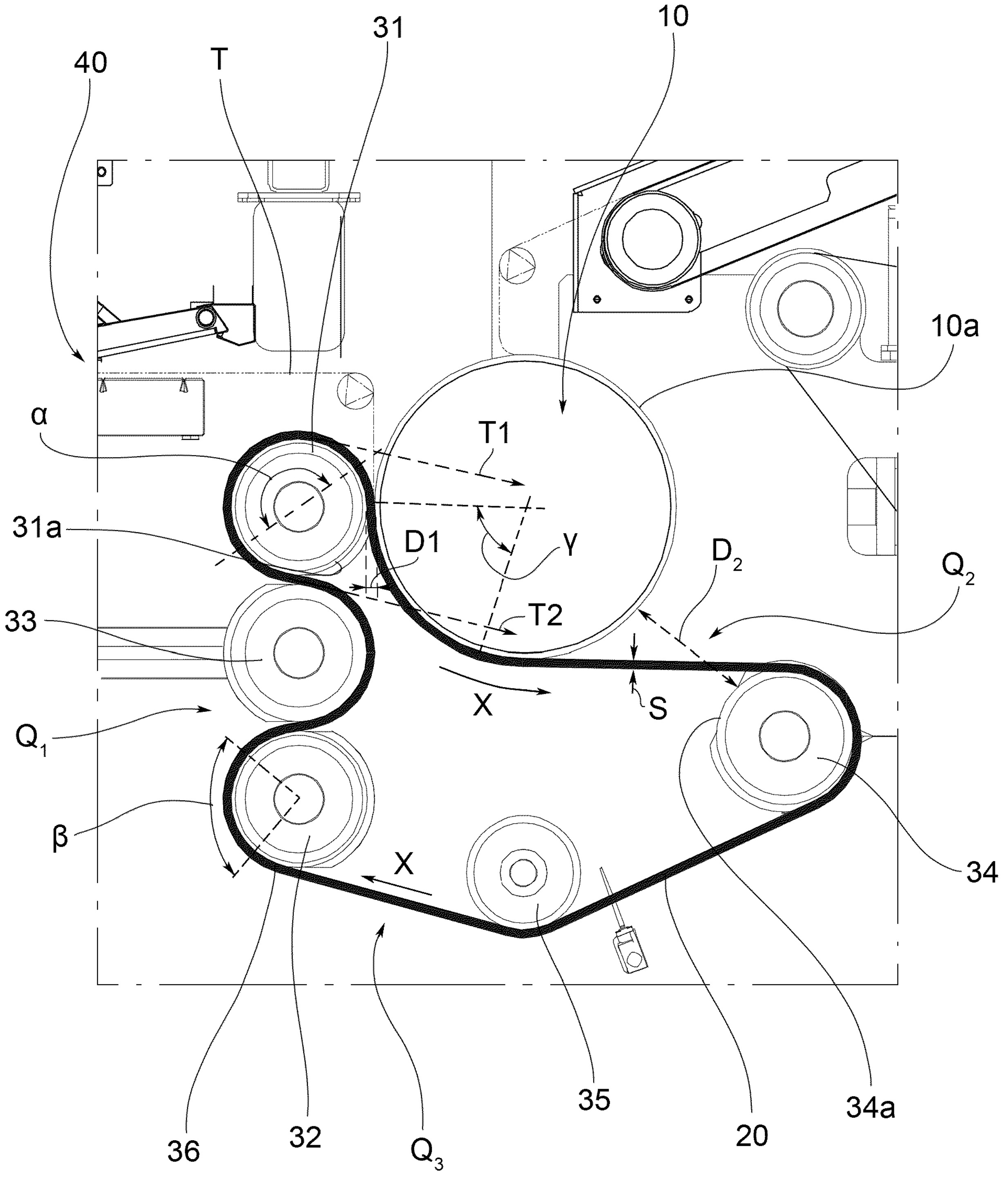


FIG.2

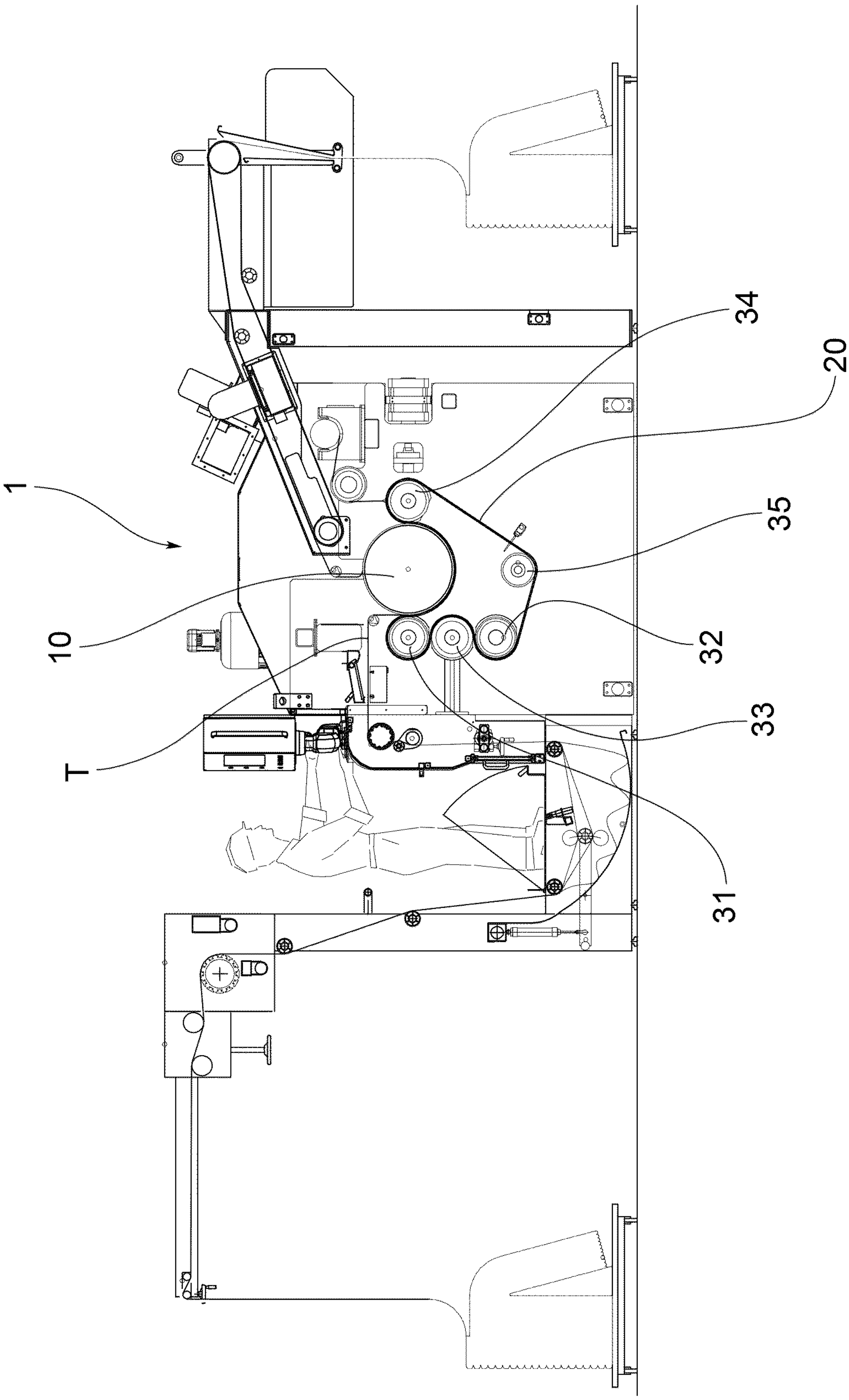


FIG.3

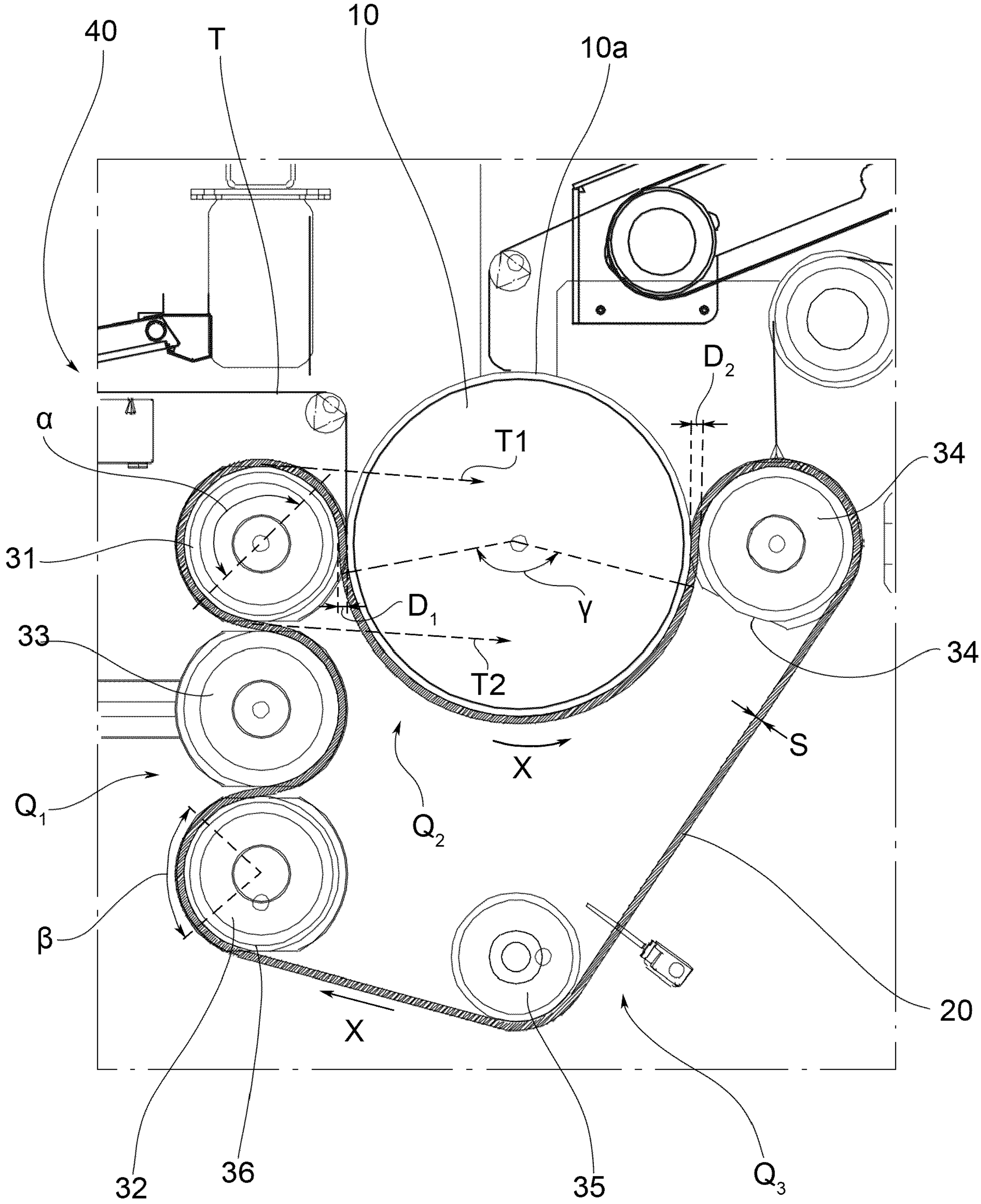
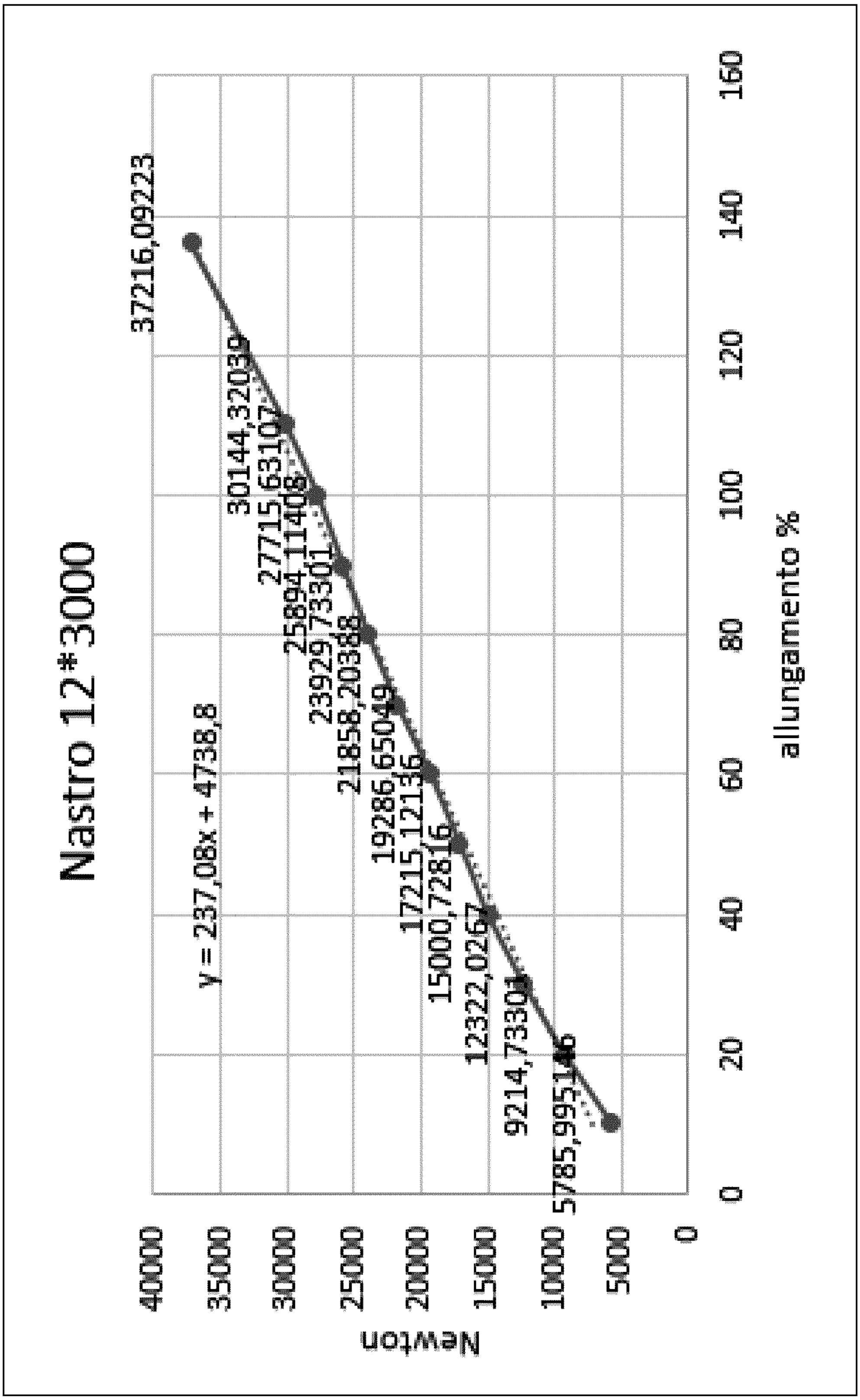


FIG.4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100
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140
160

FIG.5

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EUROPEAN SEARCH REPORT

Application Number
EP 24 17 8497

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A	EP 3 754 087 A1 (SANTEX RIMAR GROUP S R L [IT]) 23 December 2020 (2020-12-23) * paragraphs [0048] - [0050]; claim 1; figure 1 * -----	1-19	INV. D06C21/00
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D06C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	29 October 2024	Iamandi, Daniela

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