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(54) **WARPING MACHINE FOR A ROPE, ROPE MANUFACTURING MACHINE AND CORRESPONDING USE**

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Description

[0001] The present invention relates to a warping machine or winding machine for winding a rope onto a drum, particularly a so-called bobbin. Such machines are generally known in the relevant technical fields as ball warpers, e.g. see US 2,250,728.

[0002] The rope consists of a plurality of yarns, particularly more than 200 yarns, more particularly between 300 to 600 yarns, particularly made of cotton, which are bundled, twisted, braided and/or wrapped together. Each yarn can comprise a plurality of fibers, particularly more than 200 fibers, more particularly between 300 to 600 fibers, particularly made of cotton, bundled, twisted, braided and/or wrapped together. The present invention also relates to a rope manufacturing machine for manufacturing a rope and winding it onto a bobbin. Preferably, the manufacturing of the rope comprises, conveying yarns through a reed thereby causing the yarns to extend in a sheet of yarns, bundling said sheet of yarns to a rope, and winding the rope onto a bobbin. The invention also relates to the use of the rope warping machine.

[0003] Known warping machines, such as that one shown in US 1,833,495, comprise a bobbin with a rotational bobbin axis onto which a rope is wound, a traverse guide being located upstream the bobbin which reciprocates the rope along the bobbin width for distributing the rope along the same, and a pressure drum with a rotational bobbin axis being located downstream the bobbin for causing pressure onto the rope in a pressure zone between the pressure drum and the bobbin. The rope being wound on the bobbin has rope sections layered next to each other along the bobbin width and above each other in the bobbin's radial direction. In the following, said rope being wound on the bobbin and forming a substantially cylindrical shape on the same is designated as warp which is defined by its outer radius and its length along the bobbin axis.

[0004] Another rope warping machine is disclosed in US 2010 107590.

[0005] Before the rope reaches the pressure zone, it reaches a receiving zone which at the beginning of the warping process is on the bobbin, and after the first layer of rope is layered on the bobbin is on the warp. The receiving zone and the pressure zone are offset by a circumferential arc length being defined by the radius of the warp and the circumferential angle between lines extending from the bobbin axis to the receiving zone and from the bobbin axis to the pressure zone. Upon warping, the radius of the warp increases. Therefore, the rotational axis of the bobbin is movably mounted with respect to the pressure drum axis such that, upon increasing warp thickness, the bobbin axis is translationally moved relative to said pressure drum axis which affects the position of the pressure zone. In US 1,833,495, the pressure caused on the yarn in the pressure zone depends on the weight of the bobbin including the warp on the bobbin and the angle between a line extending from the bobbin

axis to the pressure drum axis and a line protruding vertically through the bobbin axis.

[0006] The reciprocating of the yarn along the warp width causes mechanical wear along the arc length and in the pressure zone, which mechanical wear is affected by several factors such as the arc length, the pressure in the pressure zone, and the friction between the rope and the bobbin or warp. One disadvantage of the above described warping machines is that, upon increasing of warp thickness, the arc length and the pressure in the pressure zone changes. Therefore the mechanical wear of the rope changes upon increasing of the warp thickness leading to inconsistent mechanical properties of the rope.

[0007] In addition to warping machines for winding ropes on a bobbin, warping machines for winding sheets of yarns on a bobbin are known, for example from DE 91 12 257 U1, EP 0 423 067 A1 and US 631 876 A. With such warping machines, the yarns are not bundled into a rope before being wound on the bobbin. Instead, the yarns are arranged in a plane when being wound on the bobbin. Such warping machines comprise a bobbin and a pressure drum, wherein it is known to guide the sheet of yarns over the pressure drum to the bobbin.

[0008] It is an object of the present invention to overcome disadvantages of known rope warping machines, in particular to provide a rope warping machine and a rope manufacturing machine where mechanical wear on the rope caused by the rope warping machine, in particular caused by the mechanical wear along the arc length and in the pressure zone, is more constant and preferably reduced. Preferably, the rope warping machine according to the present invention shall be easy to assemble and have a compact design.

[0009] This objective is solved by the subject matter of independent claim 1.

[0010] According to the invention, a warping machine for a rope made of a plurality of yarns comprises a bobbin with a rotational bobbin axis onto which the rope is wound, a pressure drum with a rotational drum axis for applying pressure onto the rope in a pressure zone between the pressure drum and the bobbin, one of the rotational axis is translationally movably mounted to the other such that said axis follows an increasing warp thickness on the bobbin, and a rope directing mechanism, wherein the rope directing mechanism is adapted to guide the rope in that it reaches a receiving zone on the pressure drum where the rope comes in contact with the pressure drum before reaching the pressure zone, and in that the receiving zone remains at the pressure drum upon the increasing warp thickness.

[0011] The rope preferably consists of a plurality of yarns, particularly more than 200 yarns, more particularly between 300 to 600 yarns, particularly made of cotton, which are bundled, twisted, braided and/or wrapped together. Each yarn can comprise a plurality of fibers, particularly more than 200 fibers, more particularly between 300 to 600 fibers, particularly made of cotton, bundled,

twisted, braided and/or wrapped together.

[0012] The rope is wound onto a winding surface, preferably being cylindrically shaped, of the bobbin. This surface is preferably defined by a bobbin width and a bobbin radius. The bobbin radius particularly extends radially from the bobbin axis and defines the circumference of the winding surface. The bobbin width particularly defines the extension of the winding surface in the direction of the bobbin axis, in particular the extension of the winding surface onto which the rope is wound. The pressure drum comprises a pressure surface, preferably being cylindrically shaped, for applying pressure onto the rope. The pressure surface is preferably defined by a drum radius and a drum width. The drum radius particularly extends radially from the drum axis and defines the circumference of the pressure surface. The drum width particularly defines the extension of the pressure surface in the direction of the drum axis. Preferably the drum width has a similar extension as the bobbin width, particular at least 80%, 90%, 100 %, 110 %, or 120 % of the bobbin width, particular of the bobbin width onto which the rope is wound. The term rotational bobbin axis shall be understood in that the bobbin can rotate around the bobbin axis and the term rotational drum axis in that the pressure drum can rotate around the drum axis. This is preferably realized in that the bobbin is rotationally mounted to a support structure and/or in that the pressure drum is rotationally mounted to a support structure. Mounting the pressure drum and the bobbin onto the same support structure leads to a more compact design of the warping machine. However, the bobbin and the pressure drum might also be mounted to separate support structures.

[0013] The pressure drum particularly serves to apply pressure to the rope in a pressure zone between the pressure drum and the bobbin. Applying pressure to the rope serves to uniformly wind the rope onto the bobbin. The pressure applied to the rope in the pressure zone is particularly realized by compressing the rope between the pressure drum and the bobbin. At the beginning of the winding, the rope is in contact with the winding surface and the pressure surface at the same time in the pressure zone. The rope being wound on the bobbin particularly has rope sections layered next to each other along the bobbin width and above each other in the bobbin's radial direction. In the following, said rope being wound on the bobbin and forming a substantially cylindrical shape on the same is designated as warp which is defined by its outer radius and its length along the bobbin axis. After the warping width onto which the rope shall be wound is covered with a first layer of wound rope, the rope is in contact with the warp and the pressure surface at the same time in the pressure zone. The pressure zone particularly lies in an axis plane extending between the bobbin axis and the drum axis. In particular, the pressure zone is located on the intersection line of the pressure surface and the axis plane.

[0014] Preferably the drum axis and the bobbin axis extend substantially parallel to each other more prefer-

ably exactly parallel to each other, to ensure a constant pressure onto the rope along the drum width.

[0015] The warping machine is particularly designed to wind the rope substantially uniformly along the bobbin width. Therefore the rope directing mechanism is preferably designed to reciprocate the rope along the bobbin width while winding the rope onto the bobbin. Preferably, the reciprocating amplitude in axial direction substantially corresponds, particularly is equal, to the bobbin width, in particular to the warp width.

[0016] The reciprocating of the rope may cause a relative movement of the rope between the bobbin and the pressure drum in the pressure zone along the bobbin width which leads to mechanical wear of the rope in the pressure zone. In order to decrease the wear in the pressure zone, the rope directing mechanism is adapted to guide the rope in that it reaches the receiving zone before reaching the pressure zone. Thereby the relative movement of the rope along the bobbin width becomes fragmented into a relative movement on the pressure drum before reaching the pressure zone and a relative movement in the pressure zone. Both relative movements cause mechanical wear. Depending on several parameters, such as the material of the rope, the warping process parameters, the surface rawness of the pressure drum, the pressure in the pressure zone, the location of the pressure zone, etc., the minimum overall mechanical wear in this regard correlates with a specific fragmentation of the relative movement on the pressure drum before reaching the pressure zone and in the pressure zone. It has been found that upon guiding the rope in that it reaches a receiving zone on the pressure drum, the mechanical fragmentation of the relative movement can be adjusted more constantly than upon guiding the rope over a receiving zone on the bobbin. One reason therefore is that the surface of the warp is rougher and bumpier compared to the surface of the pressure drum such that the relative movement on the pressure drum can be adjusted more constant. Further, the less raw surface leads to a decreased mechanical wear between the receiving zone and the pressure zone. It is therefore advantageous to indirectly guide the rope from the rope directing mechanism to the bobbin, in particular to interpose the pressure drum between the rope directing mechanism and the bobbin such that the rope is guided from the rope directing mechanism over the pressure drum to the bobbin.

[0017] In a preferred embodiment of the invention, the rope directing mechanism is adapted to guide the rope to the receiving zone in that the receiving zone is offset to the pressure zone by a circumferential arc length being defined by the pressure drum radius and an arc angle between a pressure line and a receiving line, wherein the pressure line extends from the rotational pressure drum axis to the pressure zone and the receiving line extends from the rotational pressure drum axis to the receiving zone.

[0018] Between the receiving zone and the pressure zone, the rope is particularly guided over the pressure

drum surface. Thereby, in circumferential direction, the rope is in contact with the circumferential arc length. In order to decrease mechanical wear of the rope caused by said contact, in particular caused by the relative movement between the rope and the pressure drum surface, the pressure drum rotates around its rotational axis to decrease slippage between the rope and the pressure drum surface. Preferably, the pressure drum receives the rope in the receiving zone, i.e. the rope gets in contact with the pressure drum surface, conveys the rope over the arc length, in circumferential direction, particularly by rotating, and delivers the rope to the bobbin in the pressure zone.

[0019] The circumferential arc length is defined by the pressure drum radius and the arc angle, wherein the arc angle extends between the pressure line and the receiving line. The pressure line extends radially from the drum axis to the pressure zone. Preferably, the orientation of the pressure line is identical to a line extending from the drum axis to a bobbin axis. This can particularly be achieved, by designing the warping machine in that the bobbin surface and the drum surface are cylindrically shaped in the pressure zone and particularly in that the rotational drum axis and bobbin axis are the centerlines of these cylindrically shaped surfaces. The receiving line extends radially from the drum axis to the receiving zone. The position of the receiving zone is defined by the circumferential position of the pressure drum where the rope comes in contact with the pressure drum surface first.

[0020] It has been found, that the circumferential arc length affects the mechanical wear of the rope. On one hand, a little circumferential arc length leads to a high relative movement of the rope in the pressure zone which increases mechanical wear. On the other hand, a high circumferential arc length leads to high relative movement of the rope relative to the pressure drum surface which also causes mechanical wear. It has been shown that the overall mechanical wear in this regards can be minimized by guiding the rope in that the arc angle is preferably, at least 5°, in particular between 5° to 90°, 5 to 60° or 5 to 30°, more preferably at least 7°, in particular between 7° to 90°, 7 to 60°, or 7 to 30°, most preferably at least 10°, in particular between 10° to 90°, 10° to 60°, or 10° to 30°. Particularly good results, in particular upon warping cotton ropes for denim fabrics, have been achieved by guiding the rope in that the arc angle is between 30° and 90°, 45° and 90°, or 60° and 90°, most preferably about 75°. Particular good results could be achieved by further using a pressure drum radius of preferably at least 60 mm, 70 mm, 80 mm, or 90 mm and/or preferably maximally 100 mm, 110 mm, 120 mm, 130 mm, or 140 mm.

[0021] In a preferred embodiment of the invention, the rope directing mechanism is adapted to guide the rope in that the arc angle remains greater than zero, preferably remains constant, upon the increasing warp thickness on the bobbin.

[0022] Upon winding the rope onto the bobbin, the warp thickness on the bobbin increases. In order to compensate this increasing warp thickness, one of the rotational axes is translationally movably mounted to the other. Preferably, said axis is movably mounted to the support structure. In particular, said axis is mounted in that it remains parallel to the other axis upon following the increasing warp thickness. Following the increasing warp thickness shall be understood in that said axis moves substantially to the same extent as the warp thickness increases. It has been found advantageous to adapt the rope directing mechanism in that the arc angle remains greater than zero upon the increasing warp thickness on the bobbin. In case the arc angle would turn to zero, the rope would directly be guided into the pressure zone leading to high mechanical wear. More preferably, the rope directing mechanism is adapted in that the arc angle remains constant upon the increasing warp thickness on the bobbin such that the segmentation of the relative movement between the pressure zone and the arc length remains constant.

[0023] In a preferred embodiment of the present invention, the translationally movably mounted axis is adapted to follow the increasing warp thickness along the pressure line such that a pressure line angle between the pressure line and a horizontal plane remains constant upon the increasing warp thickness, wherein the pressure line is preferably parallel to a horizontal plane such that the pressure line angle is zero.

[0024] Following the increasing warp thickness along the pressure line particularly means that the translational movement of said axis upon the increasing warp thickness moves along a vector of the pressure line in the direction of the increasing warp thickness. Thereby, the pressure line angle between the pressure line and a horizontal plane, determines the direction of movement of the movably mounted axis. Preferably, the translationally movable mounted axis is mounted in that the pressure line angle remains constant upon increasing warp thickness. This is preferably achieved in that the movably mounted axis is mounted in that it translationally moves along the initial pressure line, in particular along an initial axis plane being defined by the bobbin axis and the drum axis. The term initial pressure line or initial axis plane relates to a line or plane having a constant orientation upon warping, wherein said constant orientation is defined by the pressure line angle being present at the beginning of the warping process. It has been found advantageous to design the warping machine in that the pressure line angle is zero, i.e. the pressure line is orientated in a horizontal plane. Thereby the pressure applied to the rope in the pressure zone can be adapted independently from the weight of the bobbin, the warp, and/or the pressure drum. Thereby, unwanted forces in the pressure zone, such as circumferential forces acting on the rope, which for example appear when the pressure angle is 45°, can be reduced or minimized, thereby particularly reducing mechanical wear or other damages on the rope.

In particular as long as the receiving line remains constant, a constant pressure line leads to a constant arc angle.

[0025] In a preferred embodiment of the present invention, the rotational drum axis is mounted in a horizontal plane extending substantially, in particular exactly, on the height of the rotational bobbin axis, wherein the pressure drum axis particularly remains in this orientation with respect to the bobbin axis upon the increasing warp thickness on the bobbin. In particular, the bobbin axis and the drum axis are mounted in that, at the beginning of the warping process, the bobbin axis and the drum axis are mounted in a horizontal plane. The vertical position of said horizontal plane is particularly defined by the vertical position of the translationally movably mounted axis at the beginning of the warping process. Preferably, the movably mounted axis is mounted in that upon increasing warp thickness, it remains in the horizontal plane. More preferably the bobbin axis and the pressure drum axis are mounted in that upon increasing warp thickness, they remain in the horizontal plane. Preferably, the translationally movably mounted axis is mounted in that it moves horizontally upon the increasing warp thickness. It is particularly preferred that the horizontal plane being defined by the initial position of the movably mounted axis, remains at a constant vertical position upon increasing warp thickness. As long as the pressure drum axis and the bobbin axis remain in the same vertical plane, the pressure line angle remains zero. Thereby, the increasing weight of the bobbin does not influence the pressure in the pressure zone, such that the mechanical wear of the rope becomes more uniform, in particular reduced.

[0026] In a preferred embodiment of the present invention, the rope directing mechanism is adapted to direct a linear section of the rope from the rope directing mechanism to the receiving zone on the pressure drum, wherein the linear section of the rope is defined by a rope angle between the linear section of the rope and a horizontal plane, wherein the rope directing mechanism is adapted to guide the rope in that the rope angle between the linear section of the rope and a horizontal plane remains constant upon the increasing warp thickness, and/or a rope section length between the receiving zone and the rope directing mechanism in a vertical plane having the rotational drum axis as normal vector, wherein the rope directing mechanism is adapted to guide the rope in that the rope section length remains constant upon the increasing warp thickness.

[0027] Upon reciprocating the rope along the bobbin width, the receiving line, i.e. the receiving zone, particularly reciprocates along the pressure drum. The rope angle particularly affects the position of the receiving zone.

[0028] In a preferred embodiment of the present invention a receiving line angle between the receiving line and a horizontal plane remains constant upon the increasing warp thickness. In particular, the receiving line angle remains constant over the entire warping process such that the receiving zone remains on a constant circumferential

position. In combination with a constant pressure line angle, this leads to a constant arc angle which particularly contributes to a constant segmentation of the relative movement of the rope on the pressure drum and in the pressure zone. Since the linear section of the rope reciprocates along the bobbin width before the rope reaches the receiving zone, the rope section length, in particular in combination with the rope angle, affects the segmentation of the relative movement on the pressure drum and the pressure zone. Therefore, a constant section length and/or a constant rope angle contribute to a constant segmentation of the relative movement. It is desired, that the entire rope section length remains constant upon the entire warping process. The rope section length consists of a radial part extending in a vertical plane, wherein the vertical plane particularly has the rotational drum axis as normal vector, and an axial part extending in the direction of the rotational drum axis. The rope directing mechanism is preferably adapted to guide the rope in that the radial part of the rope section length remains constant upon the increasing warp thickness. Therefore, in particular the receiving zone angle, the rope angle, and preferably the relative position of the rope directing mechanism to the pressure drum in a vertical plane having the rotational drum axis as normal vector, shall remain constant upon the increasing warp thickness. A constant radial part of the rope section length particularly contributes to the constancy of the length of the axial part. However, it shall be clear, that a constant axial part is not necessarily required for a constant radial part of the rope section length.

[0029] In a preferred embodiment of the present invention, the translationally movably mounted axis is the drum axis such that the drum axis follows an increasing warp thickness on the bobbin. Choosing the drum axis as translationally movably mounted axis bears the advantage that the mounting of the bobbin is less complex such that inserting the bobbin into the warping machine before starting a warping process and removing the bobbin from the warping machine after the warping process, particularly after a desired length of rope has been wound on to the bobbin, is easier. More preferably, the pressure applied onto the rope in the pressure zone is affected by a pressure source applying force onto the pressure drum. In this regard, choosing the drum axis as rotationally movably mounted axis further bears the advantage that translationally moving the rotationally mounted axis and applying pressure onto the rope in the pressure zone can act in the same, preferably horizontal, direction. Since the weight of the pressure drum does not increase with the warp thickness, the pressure can be controlled more reliable and in particular easier.

[0030] In a preferred embodiment of the present invention, the rope directing mechanism follows the increasing warp thickness on the bobbin in the same direction and to the same extent as the drum axis. Preferably, the rope directing mechanism remains at a constant relative position to the pressure drum axis in a vertical plane, wherein the plane particularly has the rotational drum axis as

normal vector. It shall be clear that the term following the increasing warp thickness relates to a movement in radial direction of the bobbin axis. Accordingly, the rope directing mechanism follows the increasing warp thickness to the same extent as the drum axis in radial direction. Of course, this radial movement can be superimposed by a movement along the bobbin width, i.e. direction of the bobbin axis, such that particularly the absolute movement of the rope directing mechanism or parts of the same can be higher than that of the bobbin axis. However, the movement of the rope directing mechanism in radial direction shall be equal in direction and extent to the increasing warp thickness. This particular leads to the receiving line angle, the rope angle, and the rope section length remaining equal upon increasing warp thickness.

[0031] In a preferred embodiment of the present invention, the rope directing mechanism comprises a carriage configured to reciprocate the rope along the width of the pressure drum and a rail for guiding the carriage along a reciprocating axis parallel to the drum axis, wherein the rail is rigidly connected to the drum axis. Rigidly connecting the rail to the pressure drum axis contributes to a more easy construction and a compact design of the warping machine. The rigid connection between the rail and the pressure drum leaves only one degree of freedom of movement relative to the pressure drum axis, namely along the reciprocating axis, preferably being parallel to the drum axis. This particularly leads to the rope directing mechanism automatically following the increasing warp thickness on the bobbin in the same direction and to the same extent as the drum axis. Thereby, a constant receiving line angle, rope angle, and rope section length can be achieved. The length of the rail is preferably substantially equal to the bobbin width, such that the guide reciprocates along the bobbin width. In particular, the rail does not move relative to the pressure drum axis.

[0032] In a preferred embodiment of the present invention, the warping machine further comprises a drive means, preferably wherein the drive means rotationally drives the bobbin around the bobbin axis. Preferably, the drive means for causing a rotational movement of the bobbin is mounted in a force transmitting manner to one of the rotational axis, preferably to the bobbin axis, wherein the pressure source for affecting the pressure in the pressure zone is preferably mounted to the other rotational axis, preferably to the pressure drum axis, in a force transmitting manner. Mounting in a force transmitting manner to a rotational axis, for example the bobbin axis, preferably means that the force is directly transmitted from the drive means and/or the pressure source to the respective rotational axis, for example the bobbin axis. Directly transmitting a force to an axis particularly means that the force is first transmitted to the respective axis, for example the bobbin axis, before being transmitted to the other axis, for example the drum axis.

[0033] In a preferred embodiment of the present inven-

tion, the pressure drum is mounted at idle for freely turning around the rotational drum axis, wherein the bobbin transfers rotational driving forces of said drive means to the pressure drum. It has been found advantageous to directly drive the bobbin instead of the pressure drum and particularly to affect the rotation of the pressure drum indirectly by transferring rotational driving forces from the bobbin to the pressure drum. This surprisingly leads to reduced mechanical wear of the rope. One explanation therefore is that compared to the known warping machines, pressure in the pressure zone can be reduced. In a conventional warping machine the pressure in the pressure zone has to fulfil two requirements. A first requirement is to apply constant pressure onto the rope to ensure a uniform winding. A second requirement is to apply enough pressure to transfer the rotational driving forces from the pressure drum onto the bobbin uniformly to ensure a constant rotation of the bobbin. It has been found that the second requirement can require higher pressure than the first. With the inventive warping machine, a uniform winding does not require a uniform force transmission from the bobbin to the pressure drum, since the bobbin is directly driven. Therefore it is possible to reduce the pressure, thereby reducing the mechanical wear of the rope.

[0034] It has been found advantageous to adjust the circumferential arc length and/or the linear section of the rope, in particular the arc angle, the receiving line angle, the pressure line angle, the rope angle and/or the rope section length, by the vertical and/or horizontal distance between the pressure drum axis and the rope directing mechanism, in particular the outlet of the rope directing mechanism through which the rope is guided. In particular, the circumferential arc length, in particular the arc angle, can be increased or decreased by varying the vertical and/or horizontal distance between the rope directing mechanism, in particular the outlet of the rope directing mechanism through which the rope is guided, and the pressure drum axis. In particular the distance between the pressure drum axis and the rope directing mechanism in vertical and/or horizontal direction is held constant upon warping. Upon guiding the rope such that it comes in contact with the pressure drum before reaching the bobbin, the circumferential arc length and/or the linear section of the rope can be adjusted very precisely, in particular since the influence of the increasing warp thickness to the same is at least reduced, preferably eliminated. Particularly upon the reduced influence of the warp thickness onto the circumferential arc length and/or the linear section of the rope, the vertical and/or horizontal distance between the pressure drum axis and the rope directing mechanism can be varied in an increased range, in which the circumferential arc length and/or the linear section of the rope can be precisely and/or constantly adjusted.

[0035] The present invention also relates to the use of the previously described rope warping machine for a rope made of a plurality of yarns, in particular made by bun-

dling a sheet of yarns being substantially arranged in a horizontal plane and being separated from each other by a distance orthogonal to a conveying direction of the yarns in to a rope where the yarns are in contact with each other.

[0036] The present invention also relates to a rope manufacturing machine comprising, a bundling station for bundling a sheet of yarns into a rope and a previously described rope warping machine for winding the rope onto the bobbin. The sheet of yarns particularly extends in a plane, preferably in a horizontal plane, in which yarns, in particular bundles of yarns, are separated from each other by a distance orthogonal to a conveying direction of the yarns. The yarns in the rope, in particular said bundles of yarns, are preferably in contact with each other. Preferably, the manufacturing of the rope comprises, conveying yarns through a reed thereby causing the yarns to extend in a sheet of yarns, bundling said sheet of yarns to a rope, and winding the rope onto the bobbin.

[0037] In a preferred embodiment of the rope manufacturing machine, the bundling station is configured to bundle the sheet of yarns into the rope before reaching the rope directing mechanism.

[0038] The bundling station preferably comprises a bundling structure for reducing the extension of the yarns in directions orthogonal to a conveying direction of the yarns, preferably in a direction orthogonal to the conveying direction of the yarns in a horizontal plane. Preferably, the bundling structure has a curved structure, particularly a concave structure, for bundling the yarns. In a preferred embodiment of the present invention, the bundling station is part of the rope warping machine, in particular the bundling station is mounted, preferably rigidly mounted, to the rope warping machine, in particular to a support structure of the rope warping machine. Alternatively or additionally the rope is conveyed over at least one, preferably two, tension rolls before reaching the rope directing mechanism. The at least one tension roll particularly serves to stretch the yarn, particularly before reaching the rope directing mechanism. Preferably, at least one tension roll is mounted, preferably rigidly mounted, to the rope warping machine, in particular to a supporting structure of the rope warping machine. Further aspects, properties and features of the invention will become apparent from the following description of exemplary embodiments, taking in conjunction with the accompanying drawings, in which:

figure 1 shows a schematic diagram of a rope warping machine and a rope manufacturing machine according to the invention at the beginning of the warping process in side view;

figure 2 shows a schematic diagram of a rope warping machine and a rope manufacturing machine according to the invention in the middle of the warping process in side view;

figure 3 shows an enlarged side view of the rope warping machine in figure 1;

figure 4 shows an enlarged side view of the rope warping machine in figure 2;

figure 5 shows a technical drawing of a rope warping machine without support structure at the beginning of the warping process in side view;

figure 6 shows a technical drawing of a rope warping machine without support structure in the middle of the warping process in side view;

figure 7 shows the rope warping machine of figure 5 in top view;

figure 8 shows the rope warping machine of figure 6 in top view;

figure 9 shows the rope warping machine of figure 5 in perspective view;

figure 10 shows the rope warping machine of figure 6 in perspective view;

figure 11 shows a rope warping machine according to the invention with support structure in top view;

figure 12 shows the rope warping machine of figure 11 in front view;

figure 13 shows the rope warping machine of figure 11 in perspective view.

[0039] In the following detailed description of a preferred embodiment of the present invention a rope manufacturing machine is generally indicated by the reference number 1. Said rope manufacturing machine 1 comprises a pre-winding arrangement which is generally indicated by the reference number 3 and a rope warping machine which is generally indicated by the reference number 5. The pre-winding arrangement 3 comprises a plurality of not shown filament coils from which filaments are un-wound and conveyed to a reed 7, also known as comb. The reed includes a plurality of not shown reed bars or wires extending parallel to each other and building separated passages for the filaments to pass the reed. Preferably, a predetermined number of filaments pass through one passage thereby forming a yarn or a bundle of yarns. Downstream the reed 7, preferably a sheet of yarns 9 is conveyed to a bundling station 11. The sheet of yarns particularly extends in a plane, preferably in a horizontal plane, in which yarns, in particular bundles of yarns, are separated from each other by a distance orthogonal to a conveying direction of the yarns.

[0040] Right after leaving the reed 7, the sheet of yarns

9 is substantially arranged as the yarns in the warp in a potential later weaving process. In the bundling station 11 the sheet of yarns 9 is particularly bundled to a rope 13 where the yarns are in contact with each other such that the horizontal extension of the rope orthogonal to the conveying direction is considerably reduced compared to the sheet of yarns 9.

[0041] Downstream the bundling station 13 the rope is conveyed over two tension rolls 15, 17 arranged for tensioning the rope along its length and providing a certain increased length of rope material which is ready for warping. Preferably the tension rolls 15, 17 are mounted at idle. Particular, downstream the bundling station, the first tension role 15, has a smaller radius than the second tension role 17. From the second tension role 17, the rope is particularly conveyed to the rope warping machine 5.

[0042] In the rope form, the yarns occupy less space orthogonal to the conveying direction, such that treatments before weaving, such as dyeing, can be conducted more efficiently. For example multiple ropes can be conveyed through one dyeing station at the same time. However, before weaving, the rope 13 has to be converted again into a sheet of yarns 9 by means of the so-called re-beaming. The rope 13 is particularly exposed to many mechanical forces and chemical reactions, in particular when used as warp for a weaving process, in particular when used for producing denim fabrics. It is therefore crucial, that the rope warping machine 5, being arranged downstream the pre-winding arrangement consistently winds the rope 13 around the bobbin 23 and causes as little as possible and constant mechanical wear to the rope 13. Figure 2 illustrates a schematic view of an exemplary rope manufacturing machine 1 as shown in figure 1, however in a later process state of warping. Figure 1, shows the rope manufacturing machine 1 at the beginning of the warping process. In this state of the warping process, the first layer of rope sections is wound onto the bobbin 23. Accordingly, the warp thickness is quite small in figure 1. Contrary thereto, in the later warping process, illustrated in figure 2, a plurality of warp section layers have been wound onto the bobbin, such that the warp thickness t has increased compared to figure 1. As can be seen in the preferred embodiment shown in figure 1 and 2, the increasing warp thickness preferably affects the relative position of parts of the warping machine 5 to each other.

[0043] The schematic side views of the rope warping machine 5 shown in figure 1 and 2 are described in more detail with respect to the enlarged views of the same in figure 3 and 4.

[0044] Figure 3 and 4 illustrate schematic side views of a preferred embodiment of the rope warping machine 5 according to the present invention. Figure 3 shows the inventive rope warping machine 5 at the beginning of the warping process. Figure 4 shows the inventive rope warping machine 5 in the later warping process. The rope 13 is conveyed from the not shown second rolls 15, 17

to the rope directing mechanism 19. From the rope directing mechanism 19, the rope 13 is guided to the pressure drum 21. From the pressure drum 21, the rope 13 is guided to and wound onto the bobbin 23. Thereby, the bobbin 23 rotates around a rotational bobbin axis R_1 and the pressure drum 21 rotates around a rotational drum axis R_2 .

[0045] The rope reaches, i.e. first contacts, the pressure drum in a receiving zone 25. The location of the receiving zone 25 in circumferential direction of the bobbin 23 is preferably defined by a receiving line l_1 extending in radial direction between the drum axis R_2 and the receiving zone 25. The orientation of the receiving line l_1 in a vertical plane plain having the drum axis as normal vector is defined by a receiving line angle β between the receiving line and a horizontal plane. As can be seen in figure 3 and 4, the receiving line angle β preferably remains constant upon an increasing warp thickness, i.e. upon the warping process. In particular, the receiving line l_1 can extend vertically, i.e. the receiving line angle can be 90° . However, particularly good results, in particular upon warping cotton ropes for denim fabrics, have been achieved by guiding the rope in that the receiving line angle is between 30° and 90° , 45° and 90° , or 60° and 90° , most preferably about 75° . For uniformly winding the rope 13 onto the bobbin 23, the pressure drum 21 applies pressure onto the rope 13 in a pressure zone 27. The location of the pressure zone 27 in circumferential direction is defined by a pressure line 1, extending in radial direction between the pressure zone 27 and the pressure drum axis R_2 . The orientation of the pressure line 1, in a vertical plane having the drum axis as normal vector is defined by a pressure line angle between the pressure line and a horizontal plane. In the shown embodiment, the pressure line extends parallel to a horizontal plane, i.e. the pressure line angle is zero. As can be seen figure 3 and 4 the pressure line angle preferably remains constant upon the increasing warp thickness.

[0046] As can be seen in the embodiment of figure 3 and 4, the receiving zone 25 and the pressure zone 27 are preferably offset by a circumferential arc length 29 being defined by a pressure drum radius 31 and an arc angle α . The arc angle α extends between the receiving line l_1 and the pressure line l_2 . Thereby, one particular advantage of the invention is apparent. Upon designing the warping machine in that the receiving zone 25 is located on the pressure drum 21 having a constant pressure drum radius 31, the arc length 29 only changes when the arc angle changes. In the illustrated embodiment, the arc angle α remains constant upon an increasing warp thickness t .

[0047] Accordingly, the arc length 29 remains constant upon increasing warp thickness, thereby particularly contributing to a constant segmentation of the relative movement of the rope between pressure zone and arc length.

[0048] The arc angle α is defined by the difference between the receiving line angle β and the pressure line angle. According to the illustrated preferred embodi-

ments of the invention the arc angle α is kept constant upon the increasing warp thickness, by keeping the receiving line angle β and the pressure line angle constant. Since the pressure line l_2 is parallel to a horizontal plane, i.e. the pressure line angle is zero, the arc angle α is equal to the receiving line angle β in the shown embodiment of the present invention.

[0049] The constant pressure line angle is particularly realized in that the translationally movably mounted axis is mounted in that the translational moving direction is equal to a vector pointing from the stationary mounted axis to the movably mounted axis. In the particular embodiment shown in figure 3 and 4, the pressure drum axis R_2 is mounted in that the pressure drum axis moves upon increasing warp thickness along a vector extending from the bobbin axis R_1 to the drum axis R_2 . In particular, the movably mounted axis, preferably the pressure drum axis R_2 , is mounted in that it follows an increasing warp thickness in vertical direction. Most preferably, the pressure drum axis and the bobbin axis remain in a horizontal plane upon the entire warping process.

[0050] Another advantage of the present invention becomes apparent regarding the receiving line angle β . As long as the receiving zone 25 is located on the pressure drum 21, the receiving line angle β does not depend on the warp thickness. Therefore, the receiving line angle β can be held constant upon keeping the relative position of the rope directing mechanism 19 to the drum axis R_2 constant, in particular with respect to a vertical plane having the drum axis R_2 as normal vector. Therefore, the rope directing mechanism 19 is preferably mounted in that it moves to the same direction and to the same extent as the pressure drum axis R_2 . A preferred design of the rope directing mechanism 19 is described in more detail with respect to the figures 5 to 10.

[0051] As pointed out above, the linear section 33 of the rope between the rope directing mechanism 19 and the receiving zone 25 also affects the aimed uniform winding and reduced mechanical wear of the rope upon warping. In this regard, another advantage of keeping the receiving zone 25 on the pressure drum 21 becomes apparent. Since the pressure drum radius does not increase with the warp thickness T , the rope angle γ between the linear section 33 of the rope and a horizontal plane as well as the rope section length, in particular in a vertical plane having the drum axis R_2 as normal vector, particularly only depends on the relative position of the rope directing mechanism 19 to the drum axis R_2 . Therefore, upon mounting the rope directing mechanism in that it moves in the same direction and to the same extent as the pressure drum axis, the rope angle γ and the rope section length remains constant upon the increasing warp thickness.

[0052] An exemplary embodiment of the above described rope warping machine is described in more detail regarding to the mounting and driving of the single parts with respect to figure 5 to 10.

[0053] Preferably, the pressure drum 21 is mounted to

a drum carriage rail 35 comprising a drum rail 37 and a drum carriage 39. The drum rail 37 is preferably fixedly mounted to a support structure 57 as shown in figure 11 to 13. The drum carriage 39 is translationally movably mounted, preferably in horizontal direction, onto the drum rail 37. The pressure drum 21 is preferably mounted to a pressure drum bearing 41, in particular mounted at idle for freely rotating around the pressure drum axis R_2 . The pressure drum bearing 41 is preferably rigidly coupled to the drum carriage 39 such that the pressure drum axis R_2 moves into the same direction and to the same extent as the drum carriage 39.

[0054] Preferably, a pressure source 43 is coupled to the pressure drum 21 for causing the pressure in the pressure zone 27. The pressure source is preferably realized as cylinder, in particular as pneumatic cylinder. The pneumatic cylinder comprises an actuator rod 45 being particularly rigidly coupled to the pressure drum bearing 41 and a cylinder housing 47 being particularly rigidly coupled to the support structure 57. Rigidly coupling two entities or mounting two entities to each other shall particularly be understood in that forces applied to said entities are directly transmitted between each other. Directly transmitting a force from one entity to the other shall particularly mean that the force is transmitted without gear mechanism, such as belt transmissions or gear boxes, being interposed between the respective entities.

[0055] The actuator rod 45 is translationally movably mounted to the cylinder housing 47. In the cylinder housing 47, a preferably pneumatic pressure, in particular air pressure, applies a force onto the actuator rod 45 which transfers the force to the pressure drum 21 which in turn transfers said force into pressure in the pressure zone 25. The actuator rod 45 is preferably translationally movably mounted to the cylinder housing 47 in that the pressure rod moves into the same direction as the pressure drum 21. The pressure in the cylinder housing is preferably adapted to cause pressure of at least 0.5 bar or 1.0 bar, more preferably about 1.5 to about 2.5 bar, in the pressure zone. In order to ensure a constant pressure in the pressure zone 27, it is preferred to use a pressure sensor either directly measuring the pressure in the pressure zone or the pressure in the cylinder housing 47. Preferably, the pressure in the pressure zone is adjustable by a control unit depending on characteristics of the rope to be wound on the bobbin, such as the rope material, the number of yarns in the rope, the yarn count of the yarns in the rope or the like, and/or of winding parameters, such as the rotations per minutes of the bobbin, the tension applied to the rope by the tension rolls 15, 17, or the reciprocating frequency of the rope directing mechanism.

[0056] The rope directing mechanism 19 preferably comprises a rope carriage rail arrangement 49.

[0057] The rope carriage rail arrangement 49 preferably comprises a rope carriage 51 and a rope rail 53. The rope rail 53 is preferably rigidly coupled to the pressure drum bearing 41 such that the rope rail 53 translationally

moves into the same direction and to the same extent as the pressure drum 21. Further, the rope rail 53 particularly extends parallel to the drum axis R_2 such that the rope carriage 51 is guided parallel to the drum axis R_2 . The rope carriage 51 particularly comprises an outlet 99, such as an eyelet, through which the rope is guided, in particular enters and leaves the rope directing mechanism. The outlet 99 and the pressure drum are located to each other in such a way that the rope section angle γ is preferably less than 45° , 30° , 15° , 10° or 5° . The rope section angle γ can also be 0° such that the rope section between the pressure drum and the outlet 99 extends in a vertical plane.

[0058] However, particularly good results, in particular upon warping cotton ropes for denim fabrics, have been achieved by guiding the rope in that the rope section angle γ is between 5° and 45° , 5° and 30° , or 5° and 20° , most preferably about 15° . For causing the rope carriage 51 to reciprocate along the drum axis R_2 , a driving means 55 for the rope directing mechanism is connected to the same.

[0059] In the shown preferred embodiment of the invention, the rope rail 53 and the pressure drum bearing 41 are rigidly coupled to the drum carriage 39, such that they translationally move into the same direction and to the same extent. More preferably, the actuator rod 45 is also rigidly coupled to the drum carriage 39 such that the translational movement of the pressure drum 21 and the rope directing mechanism 19 can be controlled by the pressure source 43, in particular by the pneumatic cylinder.

[0060] As can best be seen in figure 9 and 10 the bobbin 23 is preferably coupled to an engagement device 59 for removable mounting the bobbin 23 onto the support structure 57. For this purpose, the engagement device 59 comprises an interlocking means 61 such as a wheel hub or a clutch, configured to engage the bobbin, respectively a drive shaft 63. For example, the bobbin can comprise at least one nub 65 for engaging a corresponding notch 67 provided in the interlocking means 61. Alternatively, the bobbin can comprise notches 67 and the interlocking means 61 nubs 65. In mounted position, the bobbin is preferably rigidly coupled to the interlocking means 61. Preferably, the interlocking means 61 are coupled to a bobbin bearing 69 such that the bobbin can rotate around its bobbin axis R_1 . The bobbin bearing 69 is preferably rigidly mounted to the support structure 57 such that the bobbin can rotate around its bobbin axis R_1 but is rigidly coupled to the support structure 57 such that, when mounted, a translational movement of the bobbin axis with respect to the support structure is prevented. In a preferred embodiment, the engagement device 59 further comprises at least one ball screw 77 for engaging and disengaging the bobbin to the interlocking means 61. For this purpose, the ball screw 77 is preferably mounted in that it transfers a rotational movement, in particular caused by a not shown motor and a transmission system, into a linear movement of the wheel hub

61. The rotational movement is preferably caused by a motor transferring a rotational movement, in particular by a gear-chain arrangement, to the ball screw 77. Therefore, a gear 79 is preferably rigidly connected to the ball screw 77 for transferring the rotational movement from a chain to the ball screw 77. The ball screw 77 is coupled, preferably rigidly mounted, to the interlocking means 61, such that the translational movement of the ball screw 77 causes a translational movement of the interlocking means 61. The translational movement of the ball screw and/or the interlocking means 61 is preferably directed parallel to bobbin axis R_1 . Thereby, depending on the direction of the rotational movement, the interlocking means 61 can be moved translationally towards the bobbin 23, particularly for engaging the bobbin 23 and the wheel hub 61, or translationally away from the bobbin 23, particularly for disengaging the bobbin 23 and the interlocking means 61. Preferably, the engagement device 59 comprises an interlocking means 61 on each axial end of the bobbin 23 for engaging with the bobbin on both axial sides of the bobbin 23. More preferably, each interlocking means 61 is mounted to at least one, preferably two, ball screws 77. The respective ball screws 77 of each interlocking means 61 are particularly mounted vertically above each other.

[0061] In a preferred embodiment of the invention, the bobbin 23 is driven by a not shown drive means for the bobbin 23. The drive means for the bobbin can comprise a motor, preferably a pneumatically actuated motor, more preferably a servo motor, coupled to a belt transmission transferring the driving forces from the motor to the bobbin 23, particularly to the engagement device 59 being rigidly coupled to the bobbin 23. For this purpose, a belt role 71 for transferring the driving forces of the motor to the bobbin by means of a belt, particular over the engagement device 59 to the bobbin 23, is rigidly coupled to bobbin 23, particular to the engagement device 59.

[0062] Figures 11 to 13 illustrate an exemplary rope warping machine 5 according to the present invention, wherein the bobbin 23, the pressure drum 21, and the rope directing mechanism 19 are mounted to the support structure 57, in particular to the same support structure, particularly comprising two side walls vertically extending in axial direction, wherein the above described parts of the rope warping machine preferably extend in a space between said side walls. Preferably, the sidewalls of the support structure 57 are rigidly connected to each other by means for increasing the stiffness, in particular by at least one longitudinal profile 73 extending preferably parallel to the bobbin axis and/or the drum axis of the rope warping machine 5. The longitudinal profile 73 is preferably connected removable to the sidewalls of the support structure 57, in particular by means of screws.

[0063] The drive means for the bobbin 23, particularly including the respective transmission arrangement, and/or the motor for engaging and disengaging the bobbin 23 and the interlocking means 61, particularly including the respective transmission arrangement, are pref-

erably located outside of the space between said side walls, in particular rigidly coupled to the outside of one of the sidewalls of the support structure 57. Further to that, the drive means and/or the motor including the respective transmission arrangements might be covered by a housing 75 on the outside of the sidewalls.

[0064] The inventive rope warping machine preferably comprises a positioning mechanism 77 for positioning, in particular aligning, the bobbin relative to the interlocking means 61 in order to engage the bobbin with the interlocking means 61, in particular before the warping process. Further, the positioning mechanism 77 particularly serves to move the bobbin, particularly after the warping process, away from the interlocking means 61, in particular in the direction of an open, in particular easily accessible, side of the rope warping machine 5. The positioning mechanism 77 particularly comprises a linear actuator 79, preferably a pneumatic cylinder. The linear actuator preferably comprises an actuator rod 83 for linearly, particularly vertically, displacing a bobbin seating 81 towards and/or away from the bobbin 23. The bobbin seating 81 is preferably adapted to fit, particularly designed form complimentary, to the bobbin, particular to a recess 85 in the bobbin 23. When the bobbin seating 81 engages with the bobbin 23, the linear actuator 79 particularly applies a holding force acting against the weight of the bobbin 23. When positioning the bobbin relative to the interlocking means 61, the holding force generated by the linear actuator 79 corresponds to the weight of the bobbin. After the winding process, the holding force preferably corresponds to the weight of the bobbin including the warp. The linear actuator 79 is preferably mounted to the support structure 57. More preferably, the linear actuator 79 is preferably mounted to a bobbin carriage rail arrangement 87 for translationally, preferably horizontally, moving the linear actuator 79, particular including the bobbin 23, towards or away the engagement device 59. Therefore, the linear actuator 79 is preferably rigidly mounted to a bobbin carriage 89. The bobbin carriage is preferably translationally movably mounted to a bobbin rail 91, wherein the bobbin rail 91 is particularly rigidly mounted to the support structure 57. The bobbin carriage 89 can be driven by a not shown motor, preferably by a linear actuator, more preferably by a pneumatic cylinder, for translationally, particular horizontally, moving the bobbin carriage 89 towards or away the engagement device 59, particular the interlocking means 61. Preferably, the positioning mechanism 77, comprises one of the above described linear actuator 79 and/or one of the above described bobbin carriage rail arrangements 87 on each side walls of the support structure 57. In a preferred embodiment of the present invention, entities of the pre-winding arrangement are mounted onto the rope warping machine 5, particular onto the support structure 57 of the rope warping machine. As can be seen in figure 11 to 13, a tension roll 15, 17, in particular the first tension roll 15, and/or a bundling station 11 can be mounted to the support structure 57.

[0065] The tension roll 15, 17 is preferably mounted at idle, such that it can rotate around a rotational axis, particularly extending parallel to the bobbin axis R_1 and/or to the pressure drum axis R_2 .

[0066] The bundling station preferably comprises a bundling structure 93 for bundling the sheet of yarns 9 into a rope 13. The bundling structure is particularly rigidly coupled to the support structure 57. In particular, the bundling structure 93 is fixedly connected to a bar 95 which is fixedly connected to the support structure 57, particular to each of the walls of the support structure 57. The bundling structure 93 preferably has a curved structure, in particular a concave structure. More preferably the bundling structure 93 has a circular structure, in particular in form of a ring section. Most preferably, the bundling structure 93 extends in the circumferential direction for at least 50°, 60°, 70°, 80°, or 90° and/or for maximally 110°, 130°, 150°, 180°, or 270°. The bundling structure 93 preferably comprises a surface 97 with relatively low friction on the side getting in contact with the yarns, in particular a surface leading to relatively low mechanical wear of the yarns upon bundling in the bundling station 11.

[0067] The features disclosed in the above description, the figures and the claims may be significant for the realization of the invention in its different embodiments individually or in any combination.

Reference signs

[0068]

1	rope manufacturing machine
3	pre-winding arrangement
5	rope warping machine
7	reed
9	sheet of yarns
11	bundling station
13	rope
15, 17	tension roll
19	rope directing mechanism
21	pressure drum
23	bobbin
25	receiving zone
27	pressure zone
29	arc length
31	pressure drum radius
33	linear section
35	drum carriage rail arrangement
37	drum rail
39	drum carriage
41	drum bearing
43	pressure source
45	actuator rod
47	cylinder housing
49	rope carriage rail arrangement
51	rope carriage
53	rope rail
55	driving means for the rope directing mecha-

	nism
57	support structure
59	engagement device
61	interlocking means
63	drive shaft
65	nub
67	notch
69	bobbin bearing
71	belt role
73	longitudinal profile
75	housing
77	positioning mechanism
79	linear actuator
81	bobbin seating
83	actuator rod
85	recess
87	bobbin carriage rail arrangement
89	bobbin carriage
91	bobbin rail
93	bundling structure
95	bar
97	low friction surface
99	outlet
l_1	receiving line
l_2	pressure line
R_1	bobbin axis
R_2	drum axis
t	warp thickness
α	arc angle
β	receiving angle
γ	rope angle

Claims

1. Warping machine (5) for a rope (13) made of a plurality of yarns, comprising:

- a bobbin (23) with a rotational bobbin axis (R_1) onto which the rope (13) is wound,
- a pressure drum (21) with a rotational drum axis (R_2) for applying pressure onto the rope (13) in a pressure zone (25) between the pressure drum (21) and the bobbin (23), one of the rotational axis (R_1 , R_2) is translationally movably mounted to the other such that said axis (R_1 , R_2) follows an increasing warp thickness (t) on the bobbin (23), and
- a rope directing mechanism (19),

characterized in that

the rope directing mechanism (19) is adapted to guide the rope (13) **in that** it reaches a receiving zone (25) on the pressure drum (21) where the rope (13) comes in contact with the pressure drum (21) before reaching the pressure zone (27), and **in that**

the rope directing mechanism (19) is adapted to guide the rope (13) **in that** the receiving zone (25) remains at the pressure drum (21) upon the increasing warp thickness (t).

- 5
2. Warping machine (5) according to claim 1, **characterized in that** the rope directing (19) mechanism is adapted to guide the rope (13) to the receiving zone (25) **in that** the receiving zone (25) is offset to the pressure zone (27) by a circumferential arc length (29) being defined by the pressure drum radius and an arc angle (α) between a pressure line (l_2) and a receiving line (l_1), wherein the pressure line (l_2) extends from the rotational drum axis to the pressure zone and the receiving line (l_1) extends from the rotational drum axis to the receiving zone, wherein said arc angle (α) is preferably at least 5° , in particular between 5° to 90° , 5 to 60° or 5 to 30° , more preferably at least 7° , in particular between 7° to 90° , 7 to 60° , or 7 to 30° , most preferably at least 10° , in particular between 10° to 90° , 10° to 60° , or 10° to 30° .
- 10
3. Warping machine (5) according to claim 2, **characterized in that** the rope directing mechanism (19) is adapted to guide the rope (13) **in that** the arc angle (α) remains greater than zero, preferably remains constant, upon the increasing warp thickness (t) on the bobbin (23).
- 15
4. Warping machine (5) according to claim 3, **characterized in that** the translationally movably mounted axis (R_1 , R_2) is adapted to follow the increasing warp thickness along the pressure line (l_2) such that a pressure line angle between the pressure line (l_2) and a horizontal plane remains constant upon the increasing warp thickness (t), wherein the pressure line (l_2) is preferably parallel to a horizontal plane such that the pressure line angle is zero.
- 20
5. Warping machine (5) according to one of the preceding claims, **characterized in that** the rotational drum axis (R_2) is mounted in a horizontal plane extending substantially, in particular exactly, on the height of the rotational bobbin axis (R_1), wherein the drum axis (R_2) particularly remains in this orientation with respect to the bobbin axis (R_1) upon the increasing warp thickness (t) on the bobbin (23).
- 25
6. Warping machine (5) according to one of the preceding claims, **characterized in that** the rope directing mechanism (19) is adapted to direct a linear section of the rope (33) from the rope directing mechanism (19) to the receiving zone (25) on the pressure drum (21), wherein the linear section of the rope (33) is defined by
- 30
- a rope angle (γ) between the linear section of the rope (33) and a horizontal plane, wherein
- 35
- 40
- 45
- 50
- 55

the rope directing mechanism (19) is adapted to guide the rope (13) **in that** the rope angle (γ) between the linear section of the rope (33) and a horizontal plane remains constant upon the increasing warp thickness (t), and/or

- by a rope section length between the receiving zone and the rope directing mechanism in a vertical plane, particularly having the rotational drum axis (R_2) as normal vector, wherein the rope directing mechanism (19) is adapted to guide the rope (13) **in that** the rope section length remains constant upon the increasing warp thickness (t).

7. Warping machine (5) according to one of the preceding claims 2 to 4, **characterized** in that the rope directing mechanism (19) is adapted to guide the rope (13) in that a receiving line angle (β) between the receiving line (l_1) and a horizontal plane remains constant upon the increasing warp thickness (t).

8. Warping machine (5) according to one of the preceding claims, **characterized in that** the translationally movably mounted axis (R_1 , R_2) is the drum axis (R_2) such that the drum axis (R_2) follows an increasing warp thickness (t) on the bobbin (23).

9. Warping machine (5) according to claim 8, wherein the rope directing mechanism (19) follows the increasing warp thickness (t) on the bobbin in the same direction and to the same extent as the drum axis (R_2).

10. Warping machine (5) according to one of the preceding claims, **characterized in that** the rope directing mechanism (19) comprises

- a carriage (51) configured to reciprocate the rope (13) along the width of the pressure drum and

- a rail (53) for guiding the carriage (51) along a reciprocating axis parallel to the drum axis (R_2), wherein the rail (53) is rigidly coupled to the drum axis (R_2).

11. Warping machine (5) according to one of the preceding claims, further comprising a drive means, **characterized in that** the drive means rotationally drives the bobbin (23) around the bobbin axis (R_1).

12. Warping machine (5) according to claim 11, wherein the pressure drum (21) is mounted at idle for freely turning around the rotational drum axis (R_2), wherein the bobbin (23) transfers rotational driving forces of said drive means to the pressure drum (21).

13. Use of a warping machine (5) according to one of

the preceding claims for a rope (13) made of a plurality of yarns, in particular made by bundling a sheet of yarns (9) into a rope (13).

14. Rope manufacturing machine (1) comprising:

- a bundling station (11) for bundling a sheet of yarns (9) into a rope (13) and
- a warping machine (5) according to one of the claims 1 to 12 for winding the rope (13) onto the bobbin (23).

15. Rope manufacturing machine according to claim 14, wherein the bundling station (11) is configured to bundle the sheet of yarns (9) into the rope (13) before reaching the rope directing mechanism (19).

Patentansprüche

1. Schäranlage (5) für ein aus einer Vielzahl von Garnen hergestelltes Seil (13), umfassend:

- eine Spule (23) mit einer Spulendrehachse (R_1), auf die das Seil (13) gewickelt wird,
- eine Drucktrommel (21) mit einer Trommel-drehachse (R_2) zum Aufbringen von Druck auf das Seil (13) in einem Druckbereich (25) zwischen der Drucktrommel (21) und der Spule (23), wobei eine der Drehachsen (R_1 , R_2) translatorisch beweglich an der anderen montiert ist, so dass die Achse (R_1 , R_2) einer zunehmenden Kettfadendicke (t) auf der Spule (23) folgt, und
- einen Seilleitmechanismus (19),

dadurch gekennzeichnet, dass

der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu führen, indem er einen Aufnahmebereich (25) auf der Drucktrommel (21) erreicht, wo das Seil (13) mit der Drucktrommel (21) in Kontakt kommt, bevor es den Druckbereich (27) erreicht, und dadurch, dass der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu führen, indem der Aufnahmebereich (25) bei zunehmender Kettfadendicke (t) an der Drucktrommel (21) verbleibt.

2. Schäranlage (5) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu dem Aufnahmebereich (25) zu führen, indem der Aufnahmebereich (25) zu dem Druckbereich (27) um eine Umfangsbogenlänge (29) versetzt ist, die durch den Drucktrommelradius und einen Bogenwinkel (α) zwischen einer Drucklinie (l2) und einer Aufnahmelinie (l1) definiert ist, wobei sich die Drucklinie (l2) von der

Rotationstrommelachse zu dem Druckbereich erstreckt und sich die Aufnahmelinie (11) von der Rotationsdruckachse zu dem Aufnahmebereich erstreckt, wobei der Bogenwinkel (α)

vorzugsweise mindestens 5° , insbesondere zwischen 5° bis 90° , 5 bis 60° oder 5 bis 30° beträgt,

noch bevorzugter mindestens 7° , insbesondere zwischen 7° bis 90° , 7 bis 60° oder 7 bis 30° , ganz besonders bevorzugt mindestens 10° , insbesondere zwischen 10° bis 90° , 10° bis 60° oder 10° bis 30° .

3. Schäranlage (5) nach Anspruch 2, **dadurch gekennzeichnet, dass** der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu führen, indem der Bogenwinkel (α) bei zunehmender Kettfadendicke (t) auf der Spule (23) größer als null bleibt, vorzugsweise konstant bleibt.

4. Schäranlage (5) nach Anspruch 3, **dadurch gekennzeichnet, dass** die translatorisch beweglich montierte Achse (R_1 , R_2) dazu eingerichtet ist, der zunehmenden Kettfadendicke entlang der Drucklinie (l_2) zu folgen, so dass ein Drucklinienwinkel zwischen der Drucklinie (l_2) und einer horizontalen Ebene bei zunehmender Kettfadendicke (t) konstant bleibt, wobei die Drucklinie (l_2) vorzugsweise parallel zu einer horizontalen Ebene ist, so dass der Drucklinienwinkel null ist.

5. Schäranlage (5) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Drehachse (R_2) in einer horizontalen Ebene montiert ist, die im Wesentlichen, insbesondere genau, auf der Höhe der Spulendrehachse (R_1) verläuft, wobei die Drucktrommelachse (R_2) insbesondere bei zunehmender Kettfadendicke (t) auf der Spule (23) in dieser Ausrichtung in Bezug auf die Spulenachse (R_1) bleibt.

6. Schäranlage (5) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Seilleitmechanismus (19) dazu eingerichtet ist, einen linearen Abschnitt des Seils (33) von dem Seilleitmechanismus (19) zu dem Aufnahmebereich (25) auf der Drucktrommel (21) zu leiten, wobei der lineare Abschnitt des Seils (33) durch

- einen Seilwinkel (γ) zwischen dem linearen Abschnitt des Seils (33) und einer horizontalen Ebene, wobei der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu führen, indem der Seilwinkel (γ) zwischen dem linearen Abschnitt des Seils (33) und einer horizontalen Ebene bei zunehmender Kettfadendicke (t) konstant bleibt, und/oder

- durch eine Seilabschnittslänge zwischen dem Aufnahmebereich und dem Seilleitmechanismus in einer vertikalen Ebene, insbesondere mit der Trommeldrehachse (R_2) als Normalenvektor, wobei der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu führen, indem die Seilabschnittslänge bei zunehmender Kettfadendicke (t) konstant bleibt, definiert ist.

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7. Schäranlage (5) nach einem der vorhergehenden Ansprüche 2 bis 4, **dadurch gekennzeichnet, dass** der Seilleitmechanismus (19) dazu eingerichtet ist, das Seil (13) zu führen, indem ein Aufnahmelinienwinkel (β) zwischen der Aufnahmelinie (l_1) und einer horizontalen Ebene bei zunehmender Kettfadendicke (t) konstant bleibt.

8. Schärmaschine (5) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die translatorisch beweglich montierte Achse (R_1 , R_2) die Trommelachse (R_2) ist, so dass die Trommelachse (R_2) einer zunehmenden Kettfadendicke (t) auf der Spule (23) folgt.

9. Schärmaschine (5) nach Anspruch 8, wobei der Seilleitmechanismus (19) der zunehmenden Kettfadendicke (t) auf der Spule in der gleichen Richtung und in dem gleichen Ausmaß wie die Trommelachse (R_2) folgt.

10. Schäranlage (5) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Seilleitmechanismus (19) umfasst

- einen Schlitten (51), der konfiguriert ist, um das Seil (13) entlang der Breite der Drucktrommel hin und her zu bewegen, und
- eine Schiene (53) zum Führen des Schlittens (51) entlang einer hin- und hergehenden Achse parallel zu der Trommelachse (R_2), wobei die Schiene (53) starr mit der Trommelachse (R_2) gekoppelt ist.

11. Schäranlage (5) nach einem der vorhergehenden Ansprüche, ferner umfassend ein Antriebsmittel, **dadurch gekennzeichnet, dass** das Antriebsmittel die Spule (23) um die Spulenachse (R_1) drehend antreibt.

12. Schärmaschine (5) nach Anspruch 11, wobei die Drucktrommel (21) leerlaufend montiert ist, um sich frei um die Trommeldrehachse (R_2) zu drehen, wobei die Spule (23) Drehantriebskräfte des Antriebsmittels auf die Drucktrommel (21) überträgt.

13. Verwendung einer Schäranlage (5) nach einem der vorhergehenden Ansprüche für ein aus einer Vielzahl von Garnen hergestelltes Seil (13), insbeson-

dere hergestellt durch Bündeln eines Garnbogens (9) zu einem Seil (13).

14. Seilherstellungsanlage (1) umfassend:

- eine Bündelungsstation (11) zum Bündeln eines Garnbogens (9) zu einem Seil (13) und
- eine Schärenanlage (5) nach einem der Ansprüche 1 bis 12 zum Aufwickeln des Seils (13) auf die Spule (23).

15. Seilherstellungsanlage nach Anspruch 14, wobei die Bündelungsstation (11) dazu ausgebildet ist, den Garnbogen (9) zu dem Seil (13) zu bündeln, bevor sie den Seilleitmechanismus (19) erreicht.

Revendications

1. Ourdissoir (5) pour corde (13) composée d'une pluralité de fils, comprenant :

- une bobine (23) dotée d'un axe rotationnel de bobine (R_1) sur laquelle la corde (13) est enroulée,
- un tambour de pression (21) ayant un axe rotationnel de tambour (R_2) pour appliquer de la pression sur la corde (13) dans une zone de pression (25) entre le tambour de pression (21) et la bobine (23), un des axes rotationnels (R_1 , R_2) étant monté de manière mobile en translation sur l'autre de manière à ce que ledit axe (R_1 , R_2) suive une épaisseur d'ourdissage croissante (t) sur la bobine (23), et
- un mécanisme de direction de corde (19),

caractérisé en ce que le mécanisme de direction de corde (19) est apte à guider la corde (13) par le fait qu'elle atteint une zone de réception (25) sur le tambour de pression (21) où la corde (13) vient en contact avec le tambour de pression (21) avant d'atteindre la zone de pression (27), et **en ce que** le mécanisme de direction de corde (19) est apte à guider la corde (13) par le fait que la zone de réception (25) reste sur le tambour de pression (21) lors de l'augmentation de l'épaisseur d'ourdissage (t).

2. Ourdissoir (5) selon la revendication 1, **caractérisé en ce que** le mécanisme de direction de corde (19) est apte à guider la corde (13) vers la zone de réception (25) par le fait que la zone de réception (25) est décalée vers la zone de pression (27) par une longueur d'arc circonférentiel (29) qui est définie par le rayon du tambour de pression et un angle d'arc (α) entre une ligne de pression (l_2) et une ligne de réception (l_1), la ligne de pression (l_2) s'étendant depuis l'axe rotationnel de tambour jusqu'à la zone de pression et la ligne de réception (l_1) s'étendant de

l'axe rotationnel de tambour à la zone de réception, ledit angle d'arc (α) étant de préférence d'au moins 5° , en particulier de 5° à 90° , 5° à 60° ou 5° à 30° , plus préférentiellement au moins 7° , en particulier 7° à 90° , 7° à 60° , ou 7° à 30° , plus préférentiellement au moins 10° , en particulier de 10° à 90° , 10° à 60° , 10° à 30° .

3. Ourdissoir (5) selon la revendication 2, **caractérisé en ce que** le mécanisme de direction de corde (19) est apte à guider la corde (13) par le fait que l'angle d'arc (α) reste supérieur à zéro, de préférence reste constant, lors de l'augmentation de l'épaisseur d'ourdissage (t) sur la bobine (23).

4. Ourdissoir (5) selon la revendication 3, **caractérisé en ce que** l'axe monté de manière mobile en translation (R_1 , R_2) est apte à suivre l'épaisseur d'ourdissage croissante le long de la ligne de pression (l_2) de manière à ce qu'un angle de ligne de pression entre la ligne de pression (l_2) et un plan horizontal reste constant lors de l'augmentation de l'épaisseur d'ourdissage (t), la ligne de pression (l_2) étant de préférence parallèle à un plan horizontal de manière à ce que l'angle de ligne de pression soit de zéro.

5. Ourdissoir (5) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'axe rotationnel de tambour (R_2) est monté dans un plan horizontal s'étendant sensiblement, en particulier exactement, sur la hauteur de l'axe rotationnel de bobine (R_1), l'axe de tambour (R_2) restant particulièrement dans cette orientation par rapport à l'axe de bobine (R_1) lors de l'augmentation de l'épaisseur d'ourdissage (t) sur la bobine (23).

6. Ourdissoir (5) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le mécanisme de direction de corde (19) est apte à diriger une section linéaire de la corde (33) depuis le mécanisme de direction de corde (19) jusqu'à la zone de réception (25) sur le tambour de pression (21), la section linéaire de la corde (33) étant définie par

- un angle de corde (γ) entre la section linéaire de la corde (33) et un plan horizontal, le mécanisme de direction de corde (19) étant apte à guider la corde (13) par le fait que l'angle de corde (γ) entre la section linéaire de la corde (33) et un plan horizontal reste constant lors de l'augmentation de l'épaisseur d'ourdissage (t), et/ou
- par une longueur de section de corde entre la zone de réception et le mécanisme de direction de corde dans un plan vertical, particulièrement en ayant l'axe rotationnel de tambour (R_2) comme vecteur normal, le mécanisme de direction de corde (19) étant apte à guider la corde (13)

- par le fait que la longueur de section de corde reste constante lors de l'augmentation de l'épaisseur d'ourdissage (t).
7. Ourdissoir (5) selon l'une quelconque des revendications précédentes 2 à 4, **caractérisé en ce que** le mécanisme de direction de corde (19) est apte à guider la corde (13) par le fait qu'un angle de ligne de réception (β) entre la ligne de réception (l_1) et un plan horizontal reste constant lors de l'augmentation de l'épaisseur d'ourdissage (t). 5
 8. Ourdissoir (5) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'axe monté de manière mobile en translation (R_1 , R_2) est l'axe de tambour (R_2), de sorte que l'axe de tambour (R_2) suit une épaisseur d'ourdissage croissante (t) sur la bobine (23). 10
 9. Ourdissoir (5) selon la revendication 8, **caractérisé en ce que** le mécanisme de direction de corde (19) suit l'épaisseur d'ourdissage croissante (t) sur la bobine dans le même sens et dans la même mesure que l'axe de tambour (R_2). 15
 10. Ourdissoir (5) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le mécanisme de direction de corde (19) comprend 20
 - un chariot (51) configuré pour faire aller et venir la corde (13) sur la largeur du tambour de pression et 25
 - un rail (53) pour guider le chariot (51) le long d'un axe d'alternance parallèle à l'axe de tambour (R_2), le rail (53) étant couplé rigidement à l'axe de tambour (R_2). 30
 11. Ourdissoir (5) selon l'une quelconque des revendications précédentes, comprenant en outre un moyen d'entraînement, **caractérisé en ce que** le moyen d'entraînement entraîne la bobine (23) en rotation autour de l'axe de bobine (R_1). 35
 12. Ourdissoir (5) selon la revendication 11, **caractérisé en ce que** le tambour de pression (21) est monté à vide pour tourner librement autour de l'axe rotationnel de tambour (R_2), la bobine (23) transférant des forces d'entraînement rotationnelles dudit moyen d'entraînement au tambour de pression (21). 40
 13. Utilisation d'un ourdissoir (5) selon l'une quelconque des revendications précédentes pour une corde (13) composée d'une pluralité de fils, en particulier fabriquée en regroupant une feuille de fils (9) en une corde (13). 45
 14. Machine de fabrication de cordes (1) comprenant : 50
 15. Machine de fabrication de cordes selon la revendication 14, dans laquelle la station de regroupement (11) est configurée pour regrouper la feuille de fils (9) en corde (13) avant d'atteindre le mécanisme de direction de corde (19). 55

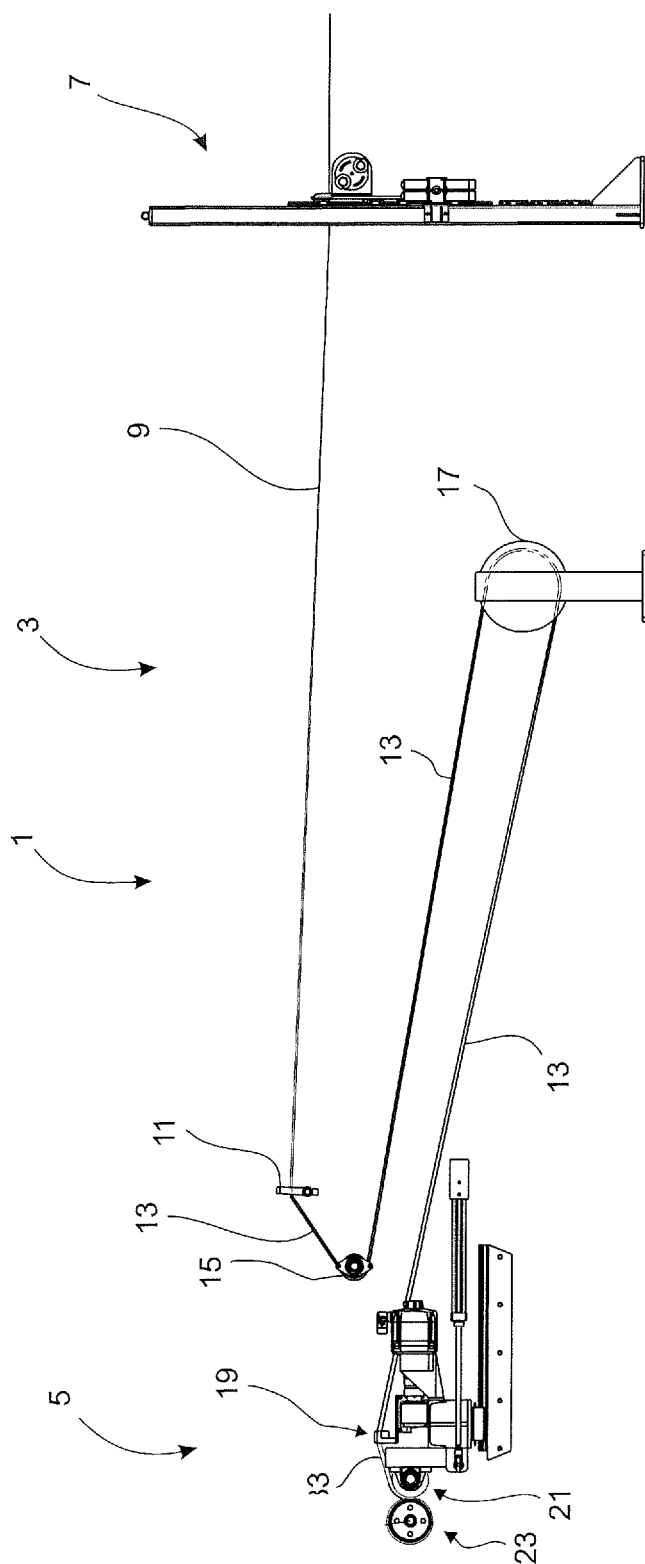


Fig. 1

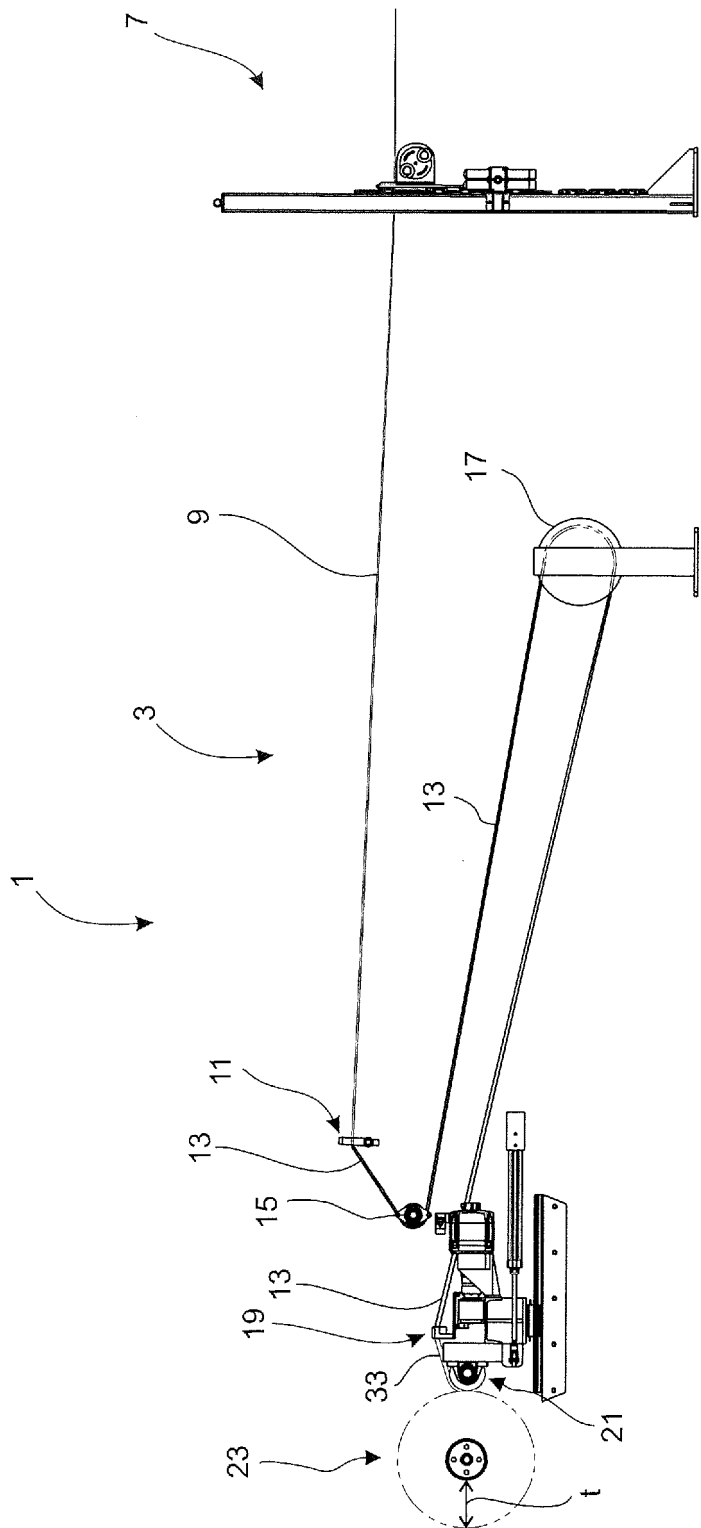


Fig. 2

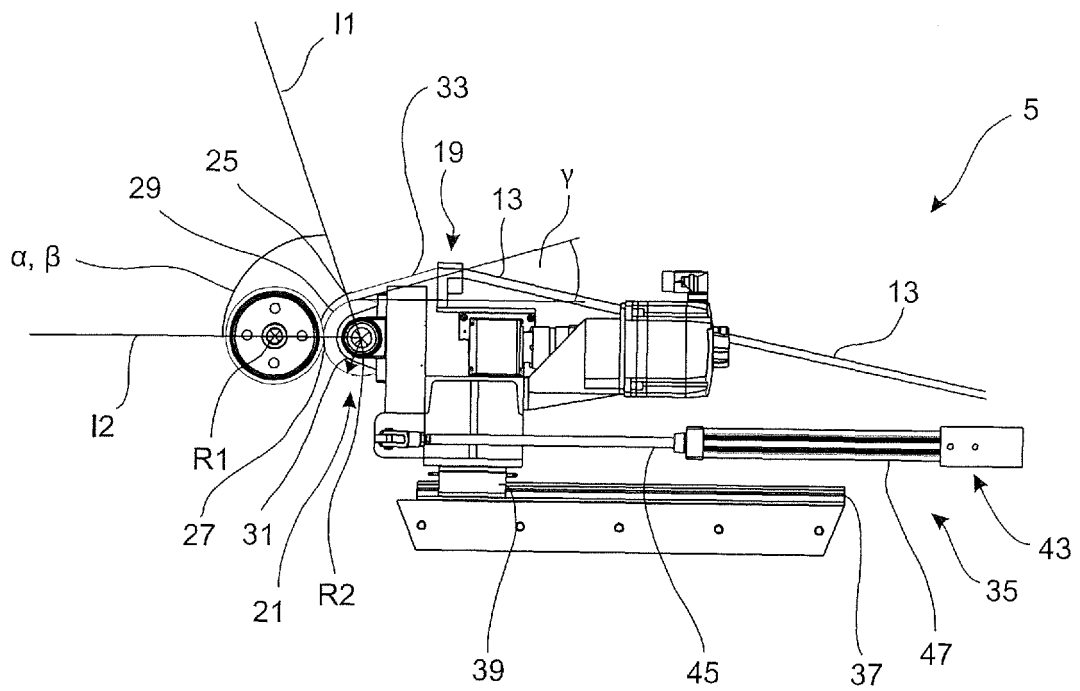


Fig. 3

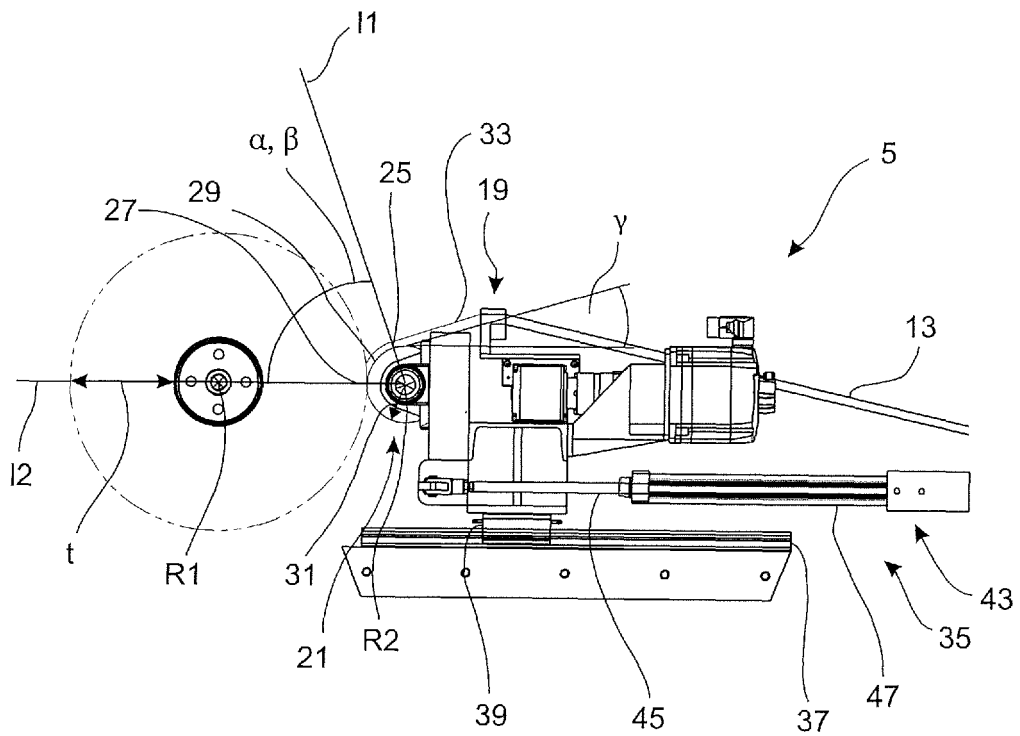


Fig. 4

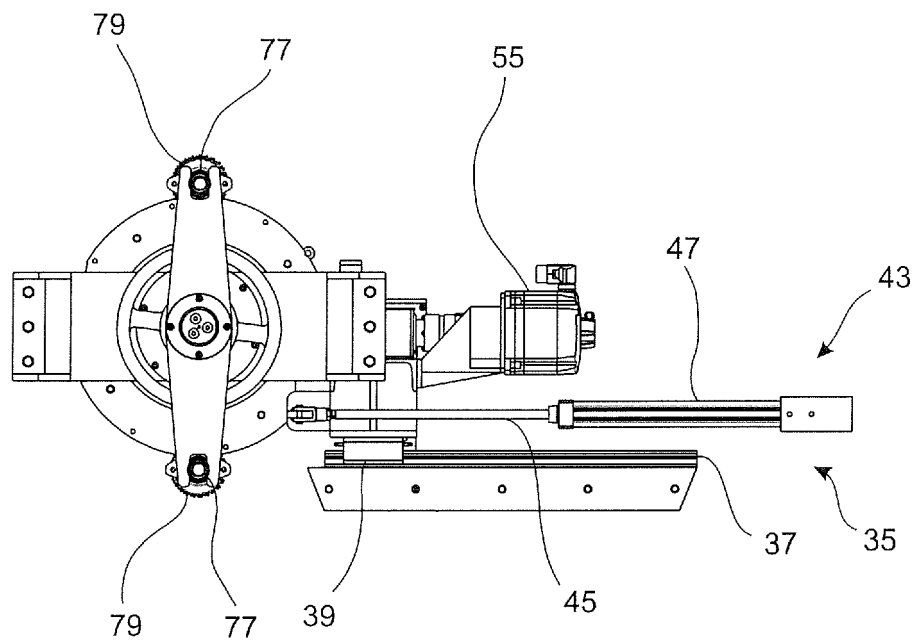


Fig. 5

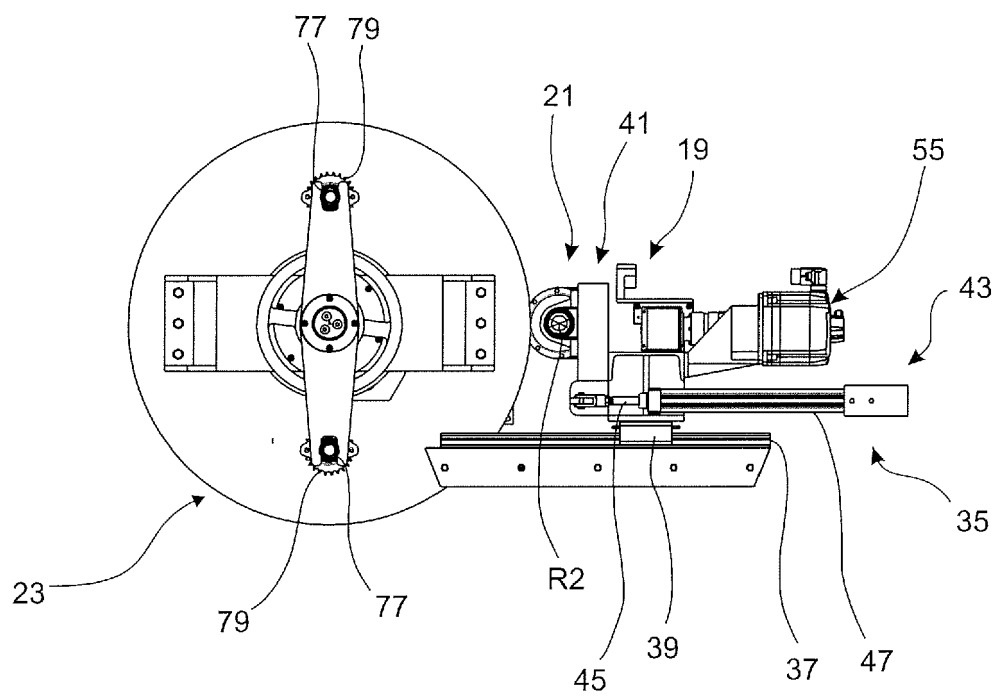
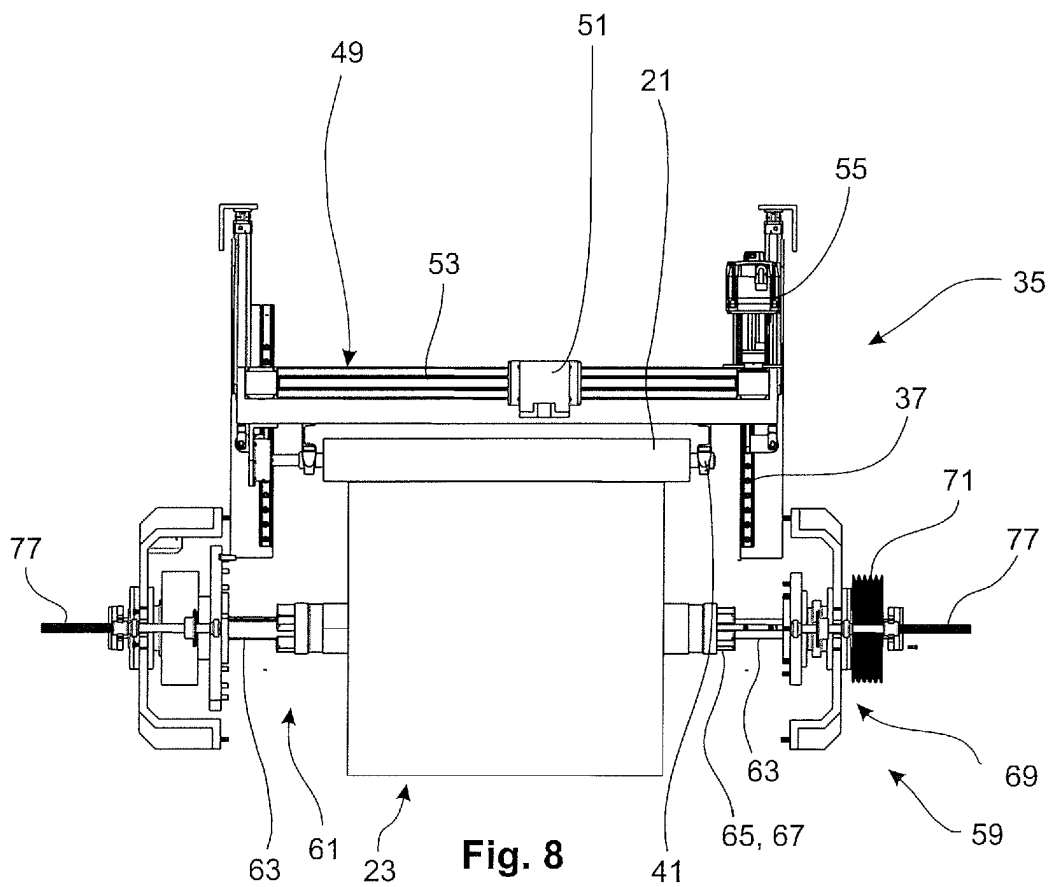
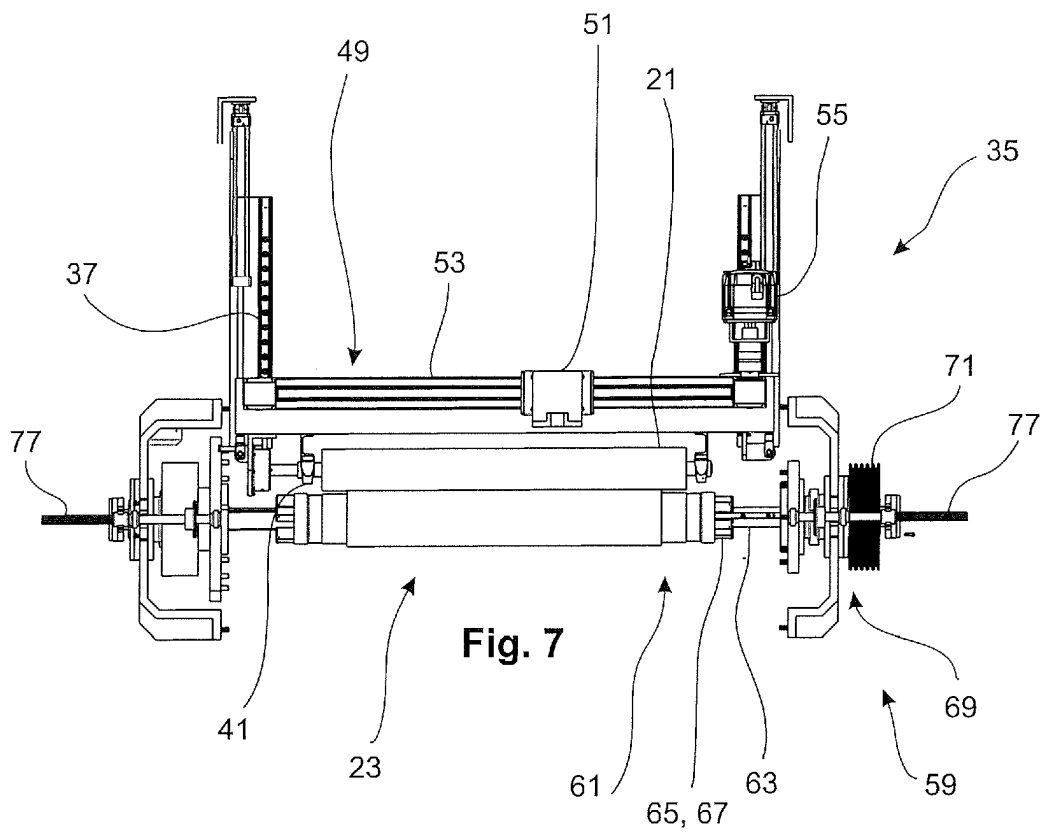


Fig. 6



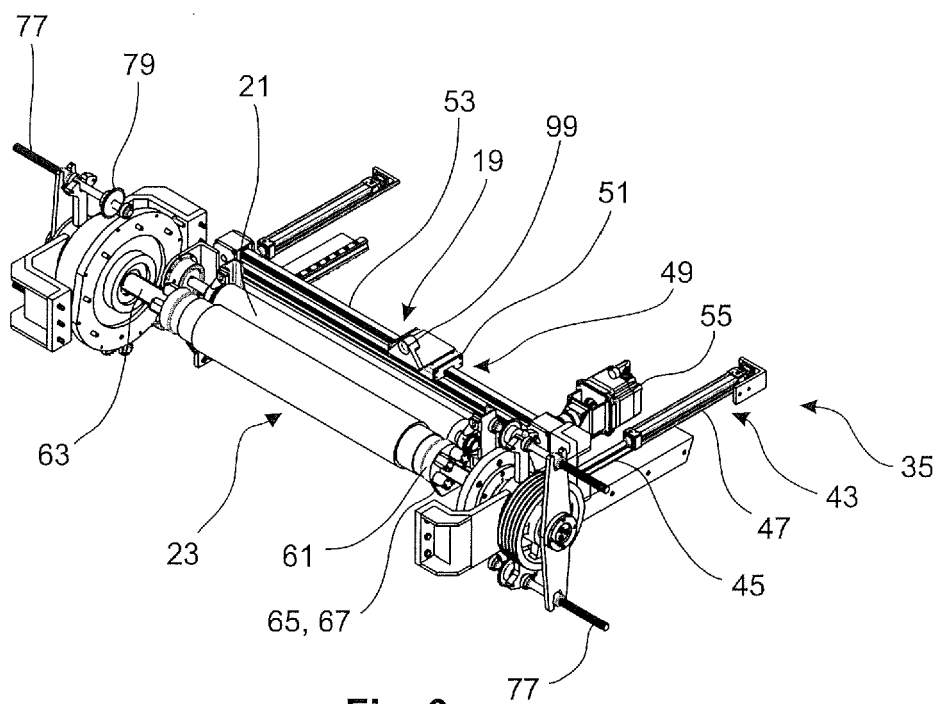


Fig. 9

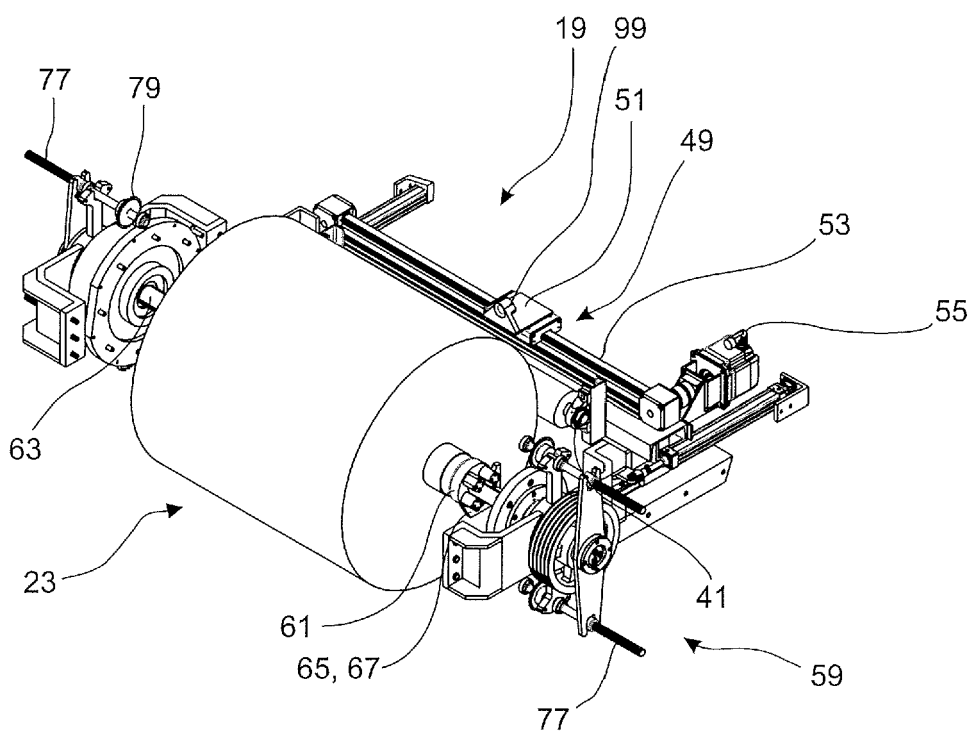
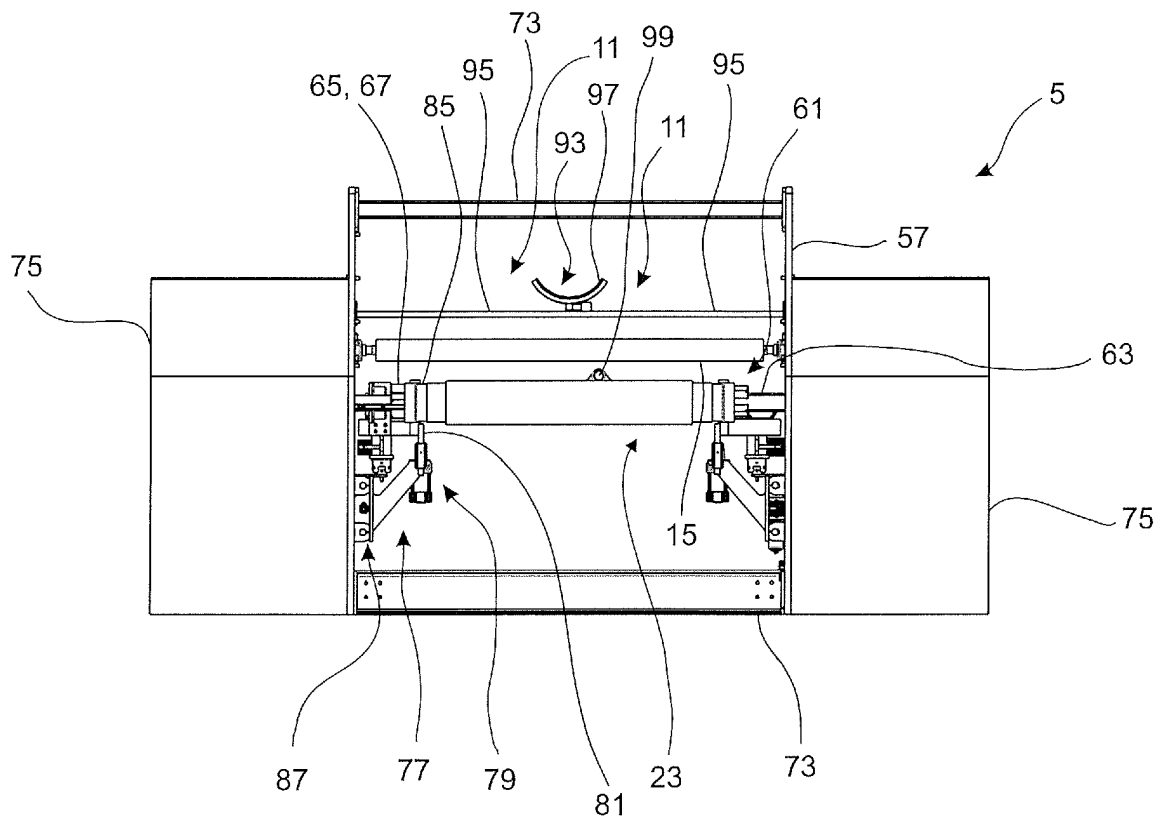
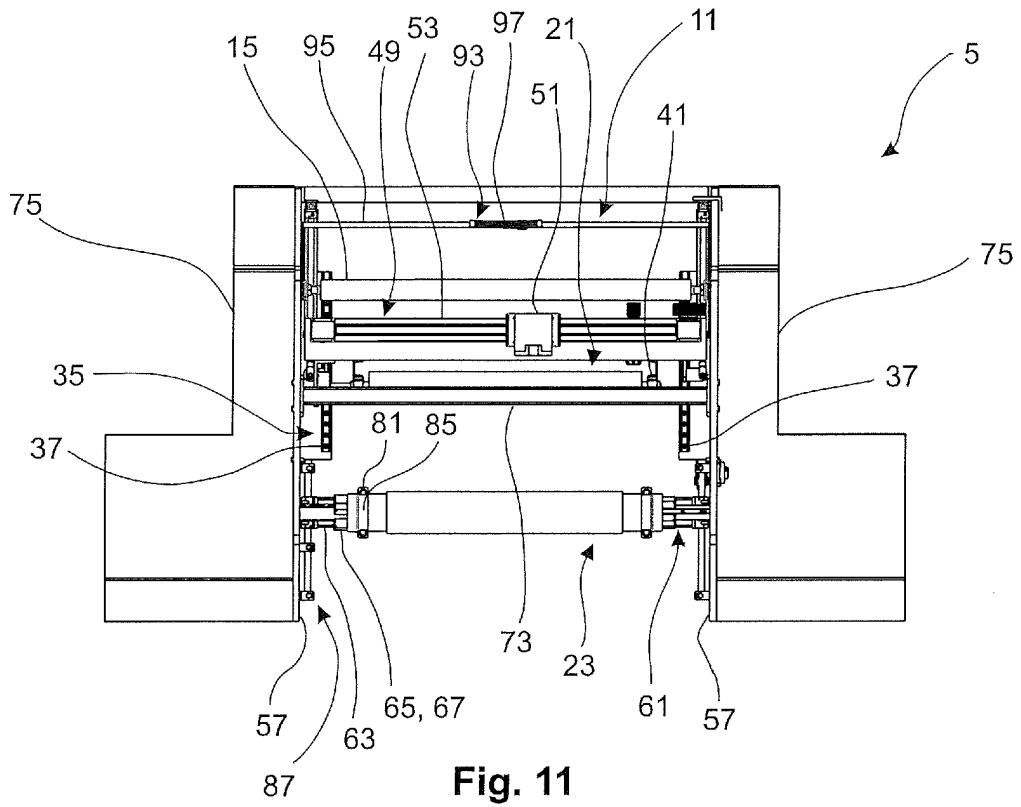


Fig. 10



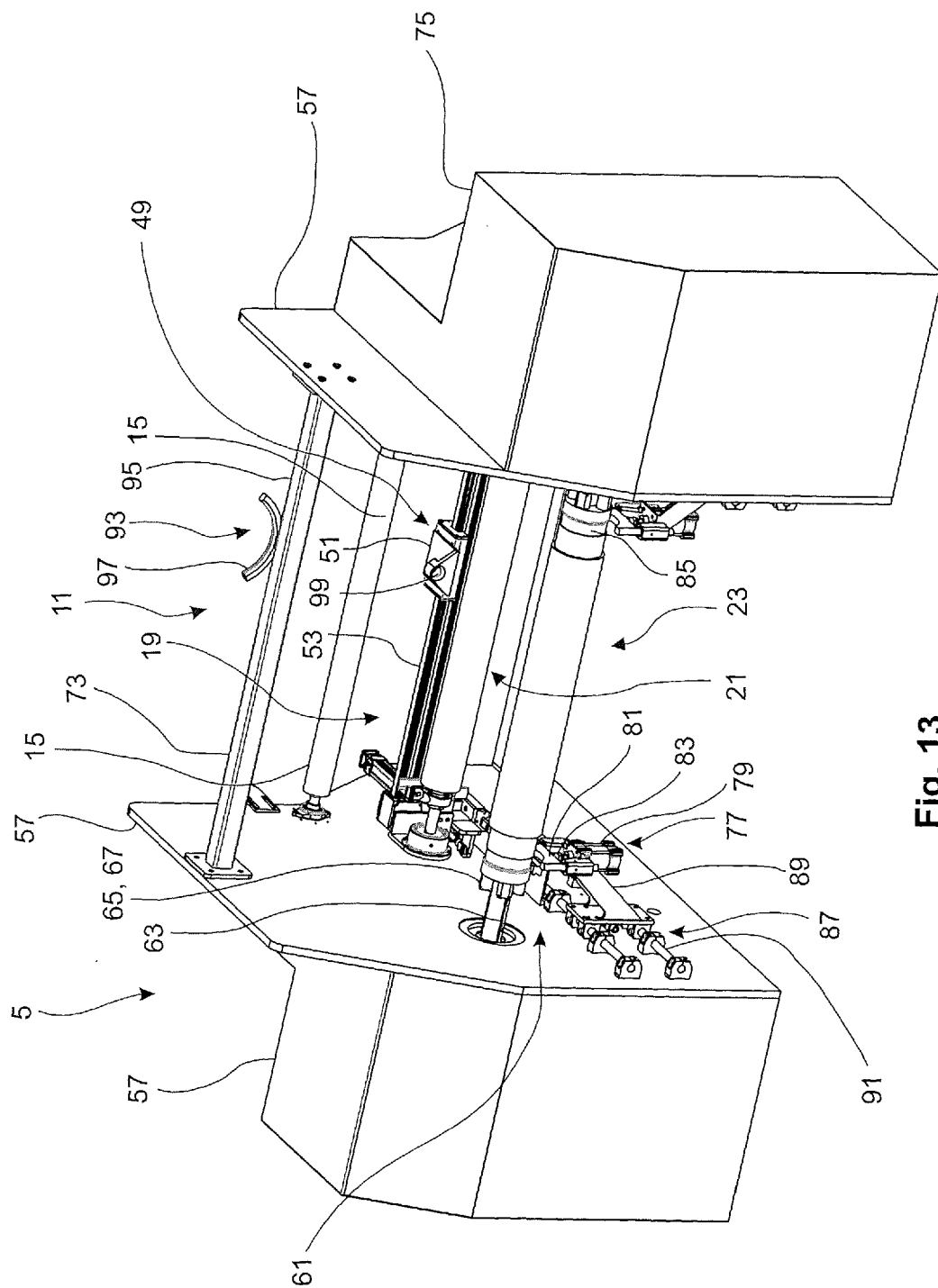


Fig. 13

REFERENCES CITED IN THE DESCRIPTION

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