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(54) METHOD AND STATION FOR FORMING A YARN ROPE AND YARN ROPE

(57) The invention relates to a method for forming a yarn rope, said yarn rope comprising a bundle of axial yarns (1,3) extending in an axial direction (A) and at least one cross yarn loop (13,15) inserted in the bundle of axial yarns (1,3) and extending in a cross direction (C), the cross direction (C) being orientated transversely, in particular perpendicularly, to the axial direction (A), wherein the method comprises the steps of receiving a plurality of separate axial yarns (1,3), creating a first insertion gap confined between the axial yarns and extending in cross direction (C), inserting a first cross yarn (13) in the first insertion gap for forming first under portions (35) and over portions (33) with respect to said axial yarns (1,3), creating a second insertion gap confined between the axial yarns (1,3) and extending in cross direction(C), inserting a second cross yarn (15) in the second insertion gap for forming second under portions (39) and over portions (37) with respect to said axial yarns (1,3), and forming the cross yarn loop by connecting the inserted first and second cross yarn (13, 15) with each other, wherein at least the step of inserting the first and/or second cross yarn (13, 15) is motor driven in particular according to a process control sequence.

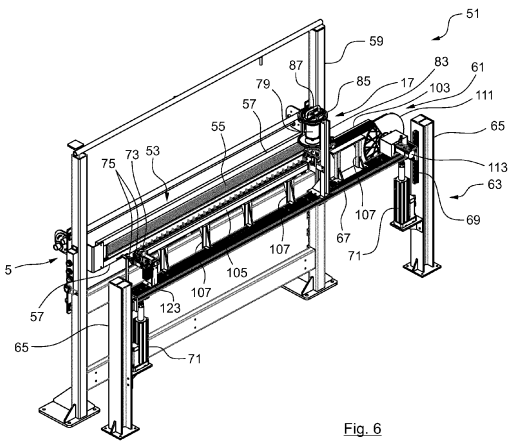

Fig. 6

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Description

[0001] The invention relates to a yarn rope comprising a bundle of axial yarns extending in an axial direction and at least one cross yarn loop inserted in the bundle of axial yarns and extending in a cross direction. The invention further relates to a method and a station for forming such yarn rope. In particular, the yarn rope is formed for processing, such as dyeing, yarns in textile industry, in particular prior to weaving.

[0002] Compared to plains of axial yarns being spaced from each other in cross direction, a bundle of axial yarns requires less space in cross direction which enables increasing the productivity of yarn processing stations, such as dyeing stations, by guiding a plurality of bundles at the same time through the station. In particular, the cross yarn loop enables rearranging axial yarns into a plain after the bundle has been processed, in particular dyed. In particular, the cross yarn enables threading axial yarns into a reed, such as a read of a weaving machine.

[0003] It is known to insert cross yarn loops into axial yarns. Thereby cross yarn loops are inserted in a plurality of axial yarns being separated from each other and extending in a plane, such as a horizontal plane. For inserting the cross yarn loop, a first group of axial yarns can be spaced from a second group of axial yarns, for example by lifting the first group relative to the second group, such that a first insertion gap is created extending in cross direction. The cross direction is usually orientated perpendicular to the axial direction of the axial yarns. Subsequently a cross yarn is inserted in the first insertion gap thereby forming under portions and over portions with respect to said axial yarns. Subsequently a second insertion gap is created, for example by lowering the first group of axial yarns relative to the second group of axial yarns, such that the first group of axial yarns extends below the second group of axial yarns. Thereafter, a second cross yarn is inserted in the second insertion gap such that the second cross yarn forms under portions with the axial yarns having over portions with the first cross yarn and over portions with the axial yarns having under portions with the first cross yarn. Thereby, separated axial yarns become enclosed by a one over portion and one under portion of the cross yarns. In order to form the cross yarn loop, the cross yarns are subsequently connected so that they form a close structure.

[0004] After the insertion of the cross yarn loop, the axial yarns can be bundled into a rope such that they require less space for further processing, such as dyeing. After processing in bundled form, the enclosure of the axial yarns by the cross yarns loop enables to separate the axial yarns from each other such that they can be rearranged in separated yarns extending in a plane. This is of particular importance when the axial yarns shall be subsequently used as warp yarns in a weaving machine. Thereby the cross yarn loop helps to separate the axial yarns from each other so that they can be threaded into a reed in particular of a weaving machine. Such cross yarn loops are also known in the art as lease strings.

[0005] With known methods, the insertion of cross yarns is time consuming, since the production of the yarn rope needs to be stopped every time a cross yarn is inserted into the axial yarns. A further time consuming aspect is that the cross yarns are integrated manually by a worker attaching the cross yarn to a bar, passing the yarn through the gap with the bar, holding the cross yarn by lifting the axial yarns in reverse direction, inserting a further cross yarn by the same procedure and subsequently connecting the cross yarns with each other to form a cross yarn loop. Further the known connecting process has been found to be time consuming. Further it can happen that the connection of the cross yarns, which is usually made by knotting, opens during the processing of the yarn rope such that the cross yarns accidently get lost. If this happens it is almost impossible to separate the yarns from each other once they have been bundled to a rope. Therefore, accidental opening of the cross yarn can lead to a significant wastage of yarns.

[0006] It is an object of the present invention to overcome drawbacks of the prior art, in particular to provide a yarn rope with a bundle of axial yarns and a cross yarn loop inserted in the bundle of axial yarns, a method for forming such yarn rope and a station for forming such yarn rope, wherein the required time for inserting the cross yarn loop in the axial yarns is reduced and/or wherein the connection of the cross yarns is more resistant against accidental opening during processing of the yarn rope.

[0007] This object is solved by the subject matter of the independent claims.

[0008] According to a first aspect of the invention, a method for forming a yarn rope is provided. The yarn rope comprises a bundle of axial yarns extending in axial direction and at least one cross yarn loop inserted into the bundle of axial yarns and extending in a cross direction, the cross direction being orientated transversely, in particular perpendicularly, to said axial direction. The method comprises the steps of receiving a plurality of separated axial yarns, creating a first insertion gap confined between the axial yarns and extending in cross direction, inserting a first cross yarn in the insertion gap for forming first under portions and over portions with respect to said axial yarns, creating a second insertion gap confined by the axial yarns and extending in cross direction, inserting a second cross yarn in the second insertion gap for forming second under portions and over portions with respect to said axial yarns and forming the cross yarn loop by connecting the inserted first and second cross yarn with each other.

[0009] In particular, the cross direction is the direction in which the axial yarns are separated from each other. In particular, before bundling the axial yarns to a rope, the axial yarns extend in a plane extending in cross direction and in axial direction. In particular, the cross direction is the direction in which the cross yarns are inserted into the insertion gap. In particular the insertion

gap is confined by the axial yarns in axial direction and in spacing direction. In particular, the spacing direction is the direction in which a first group of axial yarns is spaced from a second group of axial yarns upon forming an insertion gap.

[0010] The bundle of axial yarns comprises a plurality of yarns, particularly more than 200 yarns, more particularly between 300 to 600 yarns, particularly made of cotton or polyester, which are bundled twisted, braided and/or wrapped together. Each yarn can comprise of a plurality of fibers, particularly more than 200 fibers, more particularly between 300 to 600 fibers, particularly made of cotton or polyester, bundled, twisted, braided and/or wrapped together.

[0011] In particular, the axial direction is the direction in which the longitudinal axis of the yarn rope extends. In Particular, the yarn rope can, after its formation, be wound on a bobbin. In that case, the axial direction can extend spirally around the bobbin axis.

[0012] In particular, the cross yarn loop enables separating the axial yarns from each other, in particular in cross direction, and to arrange them in a plane. In particular, the cross yarn loop enables threading the axial yarns into a reed, in particular of a weaving machine. In particular, the rope comprises a plurality of cross yarn loops inserted into the bundle of axial yarns after predetermined lengths of a yarn rope being formed. Thereby, in case of defects, such as yarn breakage, upon processing the axial yarns in a plane, such as during weaving, the yarn rope can be cut off up to the next cross yarn loop from which the axial yarns can be separated and arranged in a plane again.

[0013] In particular, the cross yarn loop has a closed structure. In particular, the cross yarn loop is formed by connecting two ends of one single continuous cross yarn so that a closed structure is formed.

[0014] Inserting the cross yarn loop in the bundle of axial yarns particularly comprises encircling each of a plurality of the separated axial yarns, in particular each of the axial yarns, with one respective over portion of the cross yarn loop and with one respective under portion of the cross yarn loop so that each of the plurality of the separate axial yarns are encircled by the cross yarn loop in cross direction and in particular in spacing direction.

[0015] Receiving the plurality of separated axial yarns is in particular conducted by receiving the separated axial yarns with at least one, preferably two, reed like structures. A reed like structure in particular comprises a plurality of dents extending parallel to each other, in particular in spacing direction, and confining a channel for each of the separated axial yarns. In particular, the reed like structure comprises at least one bar being connected with the dents. In particular, the reed like structure comprises two bars being separated from each other in spacing direction, in particular in vertical direction, between which the dents extend. The reed like structure particularly forms a channel for each of the separated yarns through which the separated yarns are conveyed in axial direction. In particular the reed like structure enables that the axial yarns remain separated during the insertion of the cross yarn loop. In particular, receiving the plurality of separate axial yarns comprises conveying separated yarns through the reed like structure. In particular, receiving the plurality of separated yarns comprises conveying a plurality of separated yarns in that they extend in a plane extending in axial direction and in cross direction, in particular in horizontal direction. Separated particularly means that the yarns are spaced from each other in cross direction. In particular the axial yarns are spaced in cross direction in that they can be received by separated channels of the reed like structure. In particular, the separated yarns are formed upstream the reed like structure by merging a plurality of filaments or fibers into a plurality of separated yarns. In particular the separated axial yarns extend parallel to each other.

[0016] Creating the first insertion cap is particularly conducted by displacing a first group of the separated axial yarns relative to a second group of the separated axial yarns. In particular, displacing is conducted by lifting or lowering the first group of axial yarns relative to the second group of axial yarns or vice versa. In particular, the first and/or the second insertion gap is created as a shed like insertion gap, such as a shed of a weaving machine, in particular of a dobby weaving machine, being provided for inserting a weft yarn crosswise to warp yarns. In particular, the first insertion gap is created by displacing the first group of the separated axial yarns relative to the second group of separated axial yarns in a first manner, such as by lifting the first group of axial yarns over the second group of axial yarns, while the second insertion gap is created by displacing the first group of separated axial yarns relative to the second group of separated axial yarns in the reverse manner, such as by lowering the first group of axial yarns below the second group of axial yarns.

[0017] The first and/or the second insertion gap is particularly confined by the first group of axial yarns and the second group of axial yarns in the direction of displacement, in particular in vertical direction. In particular, the first and/or second insertion gap extends as continuous channel, in particular in horizontal direction, being enclosed by the separated axial yarns in vertical direction and axial direction.

[0018] Creating the first insertion gap and/or the second insertion gap is preferably conducted by a shedding device, in particular by lifting and/or lowering a shaft of a shedding device. In particular, the shedding device can be designed as the shedding device of a weaving machine, in particular of a dobby weaving machine. In particular, the shedding device can comprise a plurality of heddles for receiving axial yarns. In particular, the creation of the first insertion gap is conducted by a first shaft and a second shaft, wherein the first shaft receives a first group of separate axial yarns while the second shaft receives second group of separate axial yarns. The creation of the first insertion gap and/or of the second insertion

gap is particular realized by displacing the first and the second shaft relative to each other. In particular, the shedding device can be used for receiving the plurality of separated axial yarns. Thereby, the shaft can be used for conducting the step of receiving a plurality of separate axial yarns and for the creation of the first and/or second insertion gap. However, alternatively or additionally, it is also possible to conduct the step of receiving the plurality of separate axial yarns by a separate reed like structure being arranged upstream to the shedding device.

[0019] Inserting the first and/or second cross yarn into the insertion gap particularly comprises conveying the first and/or second cross yarn from a respective insertion gap inlet to a respective insertion gap outlet in cross direction. In particular, the first and/or second cross yarn is inserted into the first and/or second insertion gap by means of an insertion device, such as by an insertion device being known for the insertion of weft yarns during weaving with weaving machines, such as dobby weaving machines. The insertion device can be a shuttle insertion device, a projectile insertion device, a rapier insertion device or a jet insertion device. Preferably, the first and/or second cross yarn is inserted into the first and/or second insertion gap by a carrier, in particular a rapier, in particular being driven by a belt wheel. In particular, the first and the second cross yarn are inserted into the first and second insertion gap by the same insertion device. In particular the insertion of the first and/or second cross yarn comprises conveying the first and/or second cross yarn from an insertion gap inlet to an insertion gap outlet, in particular by means of an insertion device, and releasing the first and/or second cross yarn at the insertion gap outlet and preferably driving the insertion device back to the insertion gap inlet in particular for receiving the second cross yarn.

[0020] An over portion within the meaning of the present invention is a portion of a cross yarn extending over a portion of an axial yarn. An under portion within the meaning of the present invention is a portion of a cross yarn extending under a portion of an axial yarn. The terms "over" and "under" in over portion and under portion can relate to the vertical direction so that an under portion of a cross yarn would be a portion of the cross yarn extending in gravitational direction under an axial yarn. However, it shall be clear that the terms under portion and over portion do not necessarily relate to the gravitational direction. For instance, an under portion could also be a portion extending in a vertical plain on the left side of an axial yarn while an over portion could be a portion extending in this vertical plain on the right side of the axial yarns. However, in a preferred embodiment, under portions are portions extending in gravitational direction under an axial yarn while over portions extend in gravitational direction over an axial yarn.

[0021] In particular, the creation of the second insertion gap and/or the insertion of the second cross yarn is conducted relative to the creation of the first insertion gap and/or the insertion of the first cross yarn in that for a plurality of, in particular for all of, the axial yarns an over portion of the first cross yarn is followed in axial direction by an under portion of the second cross yarn or vice versa.

[0022] The step of forming the cross yarn loop particularly comprises connecting the first and second cross yarns with each other in such a way that a closed cross yarn loop is formed. In particular, a closed cross yarn loop shall be a cross yarn loop forming a closed structure, such as a circle. However, the closed cross yarn loop does in particular not have the shape of a perfect circle. In particular, in the bundled form of the yarn rope, the cross yarn loop is crumbled. In particular, the cross yarn loop alternates between over portions and under portions with respect to the axial yarns. In particular, connecting the inserted first and second cross yarn comprises connecting the end sections of the first and the second cross yarns with each other. In the preferred embodiment of providing the first cross yarn and the second cross yarn from a single continuous cross yarn, the cross yarn loop is formed by connecting the two ends of the single continuous cross yarn with each other. In a less preferred embodiment in which the first and second cross yarn are provided as separated cross yarns, each end of the first cross yarns can be connected with one respective end of the second cross yarn to form the cross yarn loop.

[0023] According to the first aspect of the present invention, at least the step of inserting the first and/or second cross yarn is motor driven in particular according to a process control sequence. In particular, the step of inserting the first and/or second cross yarn is realized by motor driving a carrier, in particular a rapier, through the first and/or second insertion gap. Additionally or alternatively, at least the step of creating the first and/or second insertion gap is motor driven in particular according to a process control sequence. In particular, the step of inserting the first and/or second cross yarn and/or the step of creating the first and/or second insertion gap are driven by separate motors. In particular the term motor driven refers to driving a step by means of a motor, in particular and electric motor, in particular a stepper motor.

[0024] In particular, the step of inserting the second cross yarn into the second insertion gap is driven by the same motor as the step of inserting the first cross yarn into the first insertion gap. In particular, the step of inserting the first and/or second cross yarn is conducted by motor driving an insertion device.

[0025] In particular, motor driving the step of creating the first and/or second insertion gap comprises displacing, in particular lifting and/or lowering, a first and/or second shaft of a shedding device. In particular, the step of creating the second insertion gap is driven by two separate motors each of which being coupled with a shaft of the shedding device or by the same motor being coupled or coupleable, in particular by means of a clutch, with both shafts.

[0026] In particular, at least one, more or all of the steps being described above and below can be motor driven

in particular according to the process control sequence.

[0027] In particular, the process control sequence determines a predetermined succession of the steps to be performed for forming the yarn rope. In particular, the process control sequence determines a predetermined succession for all process steps between the step of creating a first insertion gap, in particular the step of providing the first cross yarn, and the step of connecting the inserted first and second cross yarn with each other. In particular, the succession of a subsequent step to a previous step can relate to the subsequent step being initiated and/or terminated after a previous step. As apparent from the above and the below description, a subsequent step can partially overlap with a previous step. However, in particular, a previous step shall be either initiated or terminated before the subsequent step.

[0028] In particular, motor driving a step according to the process control sequence is realized by a control unit initiating and/or terminating the respective step by driving a respective motor. In particular, the control unit is configured to initiate and/or terminate the steps to be performed for forming the yarn rope in a predetermined succession being determined by the process control sequence. In particular, the control unit is coupled to one or more, in particular to each, of the motors for motor driving the steps to be performed for forming the yarn rope. In particular, the process control sequence is initiated in predetermined process states, such as in predetermined time intervals and/or predetermined yarn rope lengths being formed.

[0029] According to one embodiment the method further comprises the steps of providing the first cross yarn and the second cross yarn, wherein the first cross yarn and the second cross yarn are provided from a single continuous cross yarn. In particular, the first cross yarn is inserted into the first insertion gap by conveying one part of the continuous cross yarn through the insertion gap. In particular, the second cross yarn is inserted into the second insertion gap by conveying another part of the continuous cross yarn through the further insertion gap. In particular, the single continuous cross yarn is provided from a cross yarn supply, such as a cross yarn spool. In particular, the single continuous cross yarn is provided by unwinding a yarn from the cross yarn supply. In particular, the first cross yarn extends from an open end of the continuous cross yarn for at least the extension of the plurality of separate axial yarns in cross direction during the step of inserting the first cross yarn into the first insertion gap. In particular, the first cross yarn merges continuously into the second cross yarn. In particular, the first and/or second cross yarn extends continuously for at least 100%, 120%, 140%, 160%, 180% or 200% of the extension of the separate axial yarns in cross direction during the step of inserting the first and/or second cross yarn into the first and/or second insertion gap. In particular, an open end section of the second cross yarn is formed by cutting the continuous cross yarn from the cross yarn supply. Due to the continuous extension of the continuous cross yarn, each of the first and the second cross yarn comprise only one open end section. Therefore, the step of forming the cross yarn loop can in particular be realized by connecting only two end sections with each other. In particular, the step of inserting the first and/or second cross yarn into the first and/or second insertion gap is realized by conveying the first and/or second cross yarn with its respective open end section through the first and/or second insertion gap thereby pulling the remaining part of the first and/or second cross yarn through the insertion gap. In particular, a first and/or second open end section of the first and/or second cross yarn is handed over to an insertion device which subsequently conveys the first and/or second cross yarn through the first and/or second insertion gap. In particular, inserting the first and/or second cross yarn into the first and/or second insertion gap comprises conveying the cross yarn from a respective insertion gap inlet to a respective insertion gap outlet in cross direction. In particular, after conveying the first cross yarn from the insertion gap inlet to the insertion gap outlet, the insertion device is driven back to the insertion gap inlet so as to receive an end section of the second cross yarn. In particular, prior to handing over the end section of the second cross yarn to the insertion device, and open end section of the second cross yarn is formed by cutting the continuous cross yarn from the cross yarn supply. In particular, the steps of providing the first cross yarn and the second cross yarn are motor driven in particular according to the process control sequence. In particular, the steps of unwinding the first, the second and/or the continuous cross yarn from the cross yarn supply, cutting the first, second and/or continuous cross yarn from the cross yarn supply, handing over the first and/or second cross yarn to the insertion device and/or conveying the first and/or the second cross yarn through the first and/or second insertion gap are motor driven in particular according to the process control sequence.

[0030] In one embodiment, the method further comprises the steps of providing the first and the second cross yarn from a cross yarn supply, such as by winding the first and the second cross yarn from a cross yarn spool. In particular, the step of providing the second cross yarn takes place simultaneously to one or more of the steps between the steps of providing the first cross yarn and creating the second insertion gap. In particular, unwinding the second cross yarn from the cross yarn supply is realized simultaneously to the steps of handing over the first cross yarn to an insertion device, creating the first insertion gap, aligning an insertion device with the first insertion gap, inserting the first cross yarn in the first insertion gap, handing over the first inserted cross yarn to a holding device and/or driving the insertion device back to the insertion gap inlet. In particular, providing the second cross yarn from the cross yarn supply is conducted simultaneously to one of the previously mentioned steps in that a predetermined length of the second cross yarn is winded from the cross yarn supply to at least 50%,

70%, 90% or 100 % before the insertion device achieves a predetermined position for receiving the second cross yarn. In particular, the predetermined length of the second cross yarn is at least 100%, 130%, 150%, 170% or 200% of the extension of the separate axial yarns in cross direction during the step of inserting the second cross yarn into the second insertion gap. In particular, before inserting the second cross yarn into the second insertion gap, the second cross yarn is already provided from a cross yarn supply. In particular, before inserting the second cross yarn into the second insertion gap, the second cross yarn extends droopy between a closed end section of the second cross yarn merging continuously into the first cross yarn and the open end section of the second cross yarn being particularly formed by cutting the continuous cross yarn from the cross yarn supply. In particular, the predetermined length of the second cross yarn extends droopy between the closed end section and the open end section of the second cross yarn.

[0031] According to one embodiment, the method further comprises the step of handing over the first and/or second cross yarn to an insertion device by connecting an end section of the first and/or second cross yarn with a carrier, such as a rapier, of the insertion device. In particular, connecting the end section of the first and/or second cross yarn with the carrier is realized by positioning the end section of the first and/or second cross yarn into a moving path of the carrier and subsequently moving the carrier along the moving path so that it picks up the end section of the first and/or second cross yarn. In particular, positioning the end section of the first and/or second cross yarn into the moving path of the carrier is realized by grabbing the end section of the first and/or second cross yarn and pulling the first and/or second cross yarn by the end section into the moving path of the carrier. In particular, grabbing is realized by a gripper device comprising two clamps being configured to grab the end section of the first and/or second cross yarn by clamping the end section of the first and/or second cross yarn in between. In particular positioning the end section of the first and/or second cross yarn into the moving path of the carrier is realized by moving, in particular pivoting, the gripper device from a clamping position into a handing over position. After moving the gripper device into the handing over position, a motor of the cross yarn supply can be driven in that, in particular in that in reverse direction as for the step of providing the first and/or second cross yarn, the end section of the first and/or second cross yarn becomes straightened, in particular tensioned or stretched, between the gripper device and a yarn outlet of a cutting device. Thereby, handing over the first and/or second cross yarn to the insertion device can be conducted more reliable. In one embodiment, the handling device comprises two guiding wings. In particular, the guiding wings confine a v-shaped guiding path in particular for guiding the first and/or second open end section from the yarn supply, in particular from the yarn outlet, to a position between the two clamps of the handling device. In particular, the guiding wings are inclined to each other in that the v-shaped guiding path expands towards the yarn supply, in particular yarn outlet, in particular in the clamping position.

[0032] In particular, the clamping position and/or the handing over position are chosen such that the insertion device can move along the moving path without colliding with the insertion device. In particular, the moving path is aligned, in particular collinear, with an insertion path along which the insertion device moves for inserting the first and/or second cross yarn into the first and/or second insertion gap. In particular, the carrier is configured to catch the end section of the first and/or second cross yarn while moving along the moving path. In particular, the step of handing over the first and the second cross yarn to the insertion device is realized at the same place so that handing over the first and/or second cross yarn can be realized by a single gripper device. In particular, handing over the first and second cross yarn to the insertion device is realized by a single gripper device. In particular, the step of handing over the first and/or second cross yarn is motor driven in particular according to the process control sequence. In particular, the second cross yarn remains connected with the cross yarn supply until the second cross yarn has been handed over to the insertion device. In particular, after handing over the second cross yarn to the insertion device, the insertion device is decelerated, particularly stopped, for allowing a controlled step of cutting the second cross yarn from the cross yarn supply. In particular, prior to the step of inserting the second cross yarn into the second insertion gap, the second cross yarn is cut from the cross yarn supply, in particular cut from a continuous cross yarn from the cross yarn supply. After cutting the second cross yarn from the cross yarn supply, the cross yarn supply is in particular ready for providing a further first and second cross yarn for the insertion of a further cross yarn loop into the axial yarns.

[0033] According to one embodiment, the step of creating the first insertion gap and/or the second insertion gap comprises spacing, in particular spacing in spacing direction, a first group of the axial yarns from a second group of the axial yarns. In particular, spacing can comprise shifting the first group of axial yarns relative to the second group of axial yarns, shifting the second group of axial yarns relative to the first group of axial yarns or shifting both groups of axial yarns relative to each other. In particular the first group of axial yarns and the second group of axial yarns are spaced from each other in a spacing direction. In particular, the spacing direction is the vertical direction.

[0034] In particular, the axial yarns of the first group and the axial yarns of the second group are alternated in cross direction. Alternatively or additionally, the second insertion gap is created such that over portions and under portions formed by the first cross yarn bypass the plurality of axial yarns outside the second insertion gap. In particular, the step of creating the first insertion gap and/or

the second insertion gap is conducted by a shedding device, such as a shedding device being known for the insertion of weft yarns in weaving machines, such as Dobby weaving machines.

[0035] In particular, the shedding device comprises a first shaft with heddles through which the separate yarns of the first group of axial yarns extend and preferably a second shaft with heddles through which the separate axial yarns of the second group of axial yarns extend. In a less preferred embodiment, the insertion device can also comprise only one shaft with heddles for spacing the first group of axial yarns or the second group of axial yarns relative to the second group of axial yarns or to the first group of axial yarns while, respectively, the second group of axial yarns or the first group of axial yarns remains at a constant position.

[0036] In particular, the first insertion gap and/or the second insertion gap is created in the form of shed, such as a shed of a weaving machine for inserting a weft yarn between warp yarns forming the shed. In particular, the first insertion gap can be realized by lifting the first group of axial yarns relative to the second group of axial yarns. Additionally or alternatively, the second group of axial yarns can be lowered relative to the first group of axial yarns for forming the first insertion gap. In particular, forming the second insertion gap is realized by spacing the first group of axial yarns and/or the second group of axial yarns into the opposite direction as the direction for forming the first insertion gap. For instance, the second insertion gap can be realized by lowering the first group of axial yarns relative to the second group of axial yarns. Alternatively or additionally the second insertion gap can be realized by lifting the second group of axial yarns relative to the first group of axial yarns. It shall be clear that the aforementioned sequence of lifting and lowering the first and/or second group of axial yarns for forming the first and/or second insertion gap can also be realized in a reverse manner. This particularly means that where a movement has been described as a lifting, it can also be realized by lowering or vice versa. The alternation of the axial yarns of the first group and of the second group in cross direction particularly means that, in cross direction, one separate axial yarn of the first group of axial yarns is followed by one axial yarn of the second group of axial yarns. In particular, the axial yarns of the first group of axial yarns and of the second group of axial yarns are alternated in cross direction by a ratio of 1/1. In a less preferred embodiment, the axial yarns of the first group of axial yarns and of the second group of axial yarns can also be alternated by different ratios, such as by a ratio of 1/2, 1/3, 2/3 and so forth. In particular, creating the second insertion gap such that over portions and under portions formed by the first cross yarn bypass a plurality of axial yarns outside the second insertion gap can be realized by spacing the first group of axial yarns relative to the second group of axial yarns into the reverse direction compared to the formation of the first insertion gap. This can be realized by lifting the first group of axial yarns relative to the second group of axial yarns for forming the first insertion gap and by lowering the first group of axial yarns relative to the second group of axial yarns for the formation of the second insertion gap. In particular, the first insertion gap and the second insertion gap are created in such a way that at least one, preferably at least 30%, 50%, 70%, 90% or 100%, of the separate axial yarns is enclosed by an over portion of the first cross yarn and by an under portion of the second cross yarn or vice versa after the insertion of the second cross yarn into the insertion gap.

[0037] In one embodiment, the steps of inserting the first and the second cross yarn in the first and the second insertion gap comprise conveying the respective cross yarn from a respective insertion gap inlet to a respective insertion gap outlet in cross direction. In particular, the insertion gap inlets of the first and second cross yarn are located on the same side of the first and second insertion gap in cross direction. This particularly allows that handing over the first and the second cross yarn to an insertion device can be realized by a single gripper device. Additionally or alternatively, the insertion gap outlets of both cross yarns are located on the same side of the first and second insertion gap in cross direction. This particularly allows that connecting the end sections of the inserted first and second cross yarn with each other can be realized at the position where the end sections of the first and second cross yarn leave the first and second insertion gap. In particular, handing over the first and the second cross yarn to the insertion device is realized at an insertion gap inlet, in particular by a common insertion gap inlet of the first and the second insertion gap. In particular, connecting the end sections of the first and the second cross yarn is realized at an insertion gap outlet, in particular at a common insertion gap outlet. In particular, inserting the first and second cross yarn is realized in that the end sections of the first and the second cross yarn leave the insertion gap at a common insertion gap outlet, in particular in order to be connected with each other near to the common insertion gap outlet.

[0038] According to one embodiment, the step of connecting the first and second inserted cross yarn is conducted by connecting end sections of the first and second cross yarn, in particular by splicing. In particular, the first cross yarn and the second cross yarn are provided by one single continuous cross yarn so that each of the first and second cross yarns comprises only one end section which has to be connected with the other end section so as to form the cross yarn loop. In particular the end section of the second cross yarn is provided as open end section by cutting the cross yarn from a cross yarn supply before inserting the second cross yarn in the insertion gap. In particular, the end sections of the first and the second cross yarn are open end sections. In particular, the end section of the first cross yarn is handed over by the inserting device to a first holding device at the insertion gap outlet. In particular, the end section of the second cross yarn is handed over by the insertion device to a

second holding device at the insertion gap outlet. In particular, handing over the first end section and/or the second end section to the first and/or the second holding device comprises grabbing the first and/or the second end section by clamps of the first and/or second holding device and subsequently driving the insertion device back to the insertion gap inlet so as to release the first and/or second cross yarn. In particular, the holding device holds the end sections of the first and/or second cross yarn in that the first and/or second end sections are released from the insertion device by driving the insertion device back to the insertion gap inlet.

[0039] Connecting the end sections of the first and second cross yarn is in particular realized by splicing the end sections. Thereby, the end sections of the first and second cross yarn are in particular handed over to the holding device in that both end sections pass through a splicer. The splicer particularly comprises a groove through which the end sections extend when being held by the holding device. Splicing particularly comprises exposing the end sections with a compressed gas, in particular compressed air, so as to entangle the end sections with each other. In particular, the compressed gas is heated so as to additionally connect the end sections of the first and second cross yarns with each other by heat treatment, such as by melting. In particular, the splicer is arranged in between the shedding device and the first and/or second holding device. In a less preferred embodiment, the step of connecting the first and second cross yarn with each other can also be conducted by other connecting methods, such as knotting. In particular, the step of handing over the end sections of the first and/or second cross yarn to the holding device, the step of grabbing the end sections of the first and/or second cross yarn and/or the step of connecting the inserted cross yarns with each other is motor driven in particular according to the process control sequence.

[0040] In one embodiment at least the step of creating the first and/or second insertion gap, connecting the inserted first and second cross yarn with each other, providing the first and/or second cross yarn, and/or handing over the first and/or second cross yarn to an insertion device is motor driven, in particular according to a process control sequence.

[0041] According to one embodiment, the insertion of the cross yarn loop is initiated according to the process control sequence, wherein the process control sequence preferably initiates the insertion of the cross yarn loop in predetermined process states, such as in predetermined time intervals and/or predetermined yarn rope lengths being formed. In particular, the insertion of the cross yarn loop comprises all steps from providing the first cross yarn until connecting the inserted first and second cross yarn with each other. In particular, before inserting the cross yarn loop into the axial yarns, the process control sequence comprises a step of stopping the delivery of axial yarns in axial direction. In particular, stopping the delivery of axial yarns is realized by stopping a drive of a bobbin onto which the yarn rope is winded after the insertion of the cross yarn loop. In particular, after the insertion of the cross yarn loop, the process control sequence comprises a step of restarting the delivery of axial yarns in particular by driving the bobbin onto which the rope is winded.

[0042] In particular, a control unit is configured to initiate the insertion of the cross yarn loop according to the process control sequence after receiving a signal indicating that a predetermined process state has been achieved. In particular, the control unit is connected with a measuring device, in particular a sensor, providing respective signals to the control unit. In particular, the measuring device measures the rotations of a bobbin or of a drive for the bobbin and provides the control unit with the respective information. The control unit particularly calculates the yarn rope length being produced from the rotations being measured by the measuring device. In particular, the process control sequence initiates the insertion of the cross yarn loop at least after every 50 meter, 250 meter, 500 meter, 1000 meter or 1500 meter of yarn rope being produced. In particular, the process control sequence initiates the insertion of the cross yarn loop more frequently, in particular every 50 meter, 100 meter or 200 meter, at the beginning and/or the end of a yarn rope forming process. In particular, a yarn rope forming process lasts for the production of at least 10.000 meter, 50.000 meter or 100.000 meter of yarn rope. In particular, the beginning and/or the end of the yarn rope forming process, comprises the first and/or last 50 to 1000 meter, in particular 100 to 500 meter, of the yarn rope production. The more frequent insertion of the cross yarn loop at the beginning and at the end of the yarn rope production has been found particularly advantageous, because it has been found that operating errors often happen by threading the separate yarns into a reed so that it can be necessary to cut off the axial yarns up to the next cross yarn loop in order to properly thread the axial yarns into the reed. The above described length of the yarn rope in which the cross yarn loop is inserted more frequently has been found to be a good compromise between decreasing material wastage upon threading the axial yarns into a reed and maintaining a high productivity of the yarn rope manufacturing process. In particular, in between the beginning and/or the end of the yarn rope forming process the process control sequence initiates the insertion of the cross yarn loop at least every 500 meter, 1.000 meter or 1.500 meter.

[0043] According to one embodiment, the method comprises one or more of the following steps being conducted according to the following process control sequence:

First step: providing the first cross yarn from a cross yarn supply;
Second step: handing over the first cross yarn to an insertion device;
Third step: creating the first insertion gap;

Fourth step: aligning the insertion device with the first insertion gap;
Fifth step: inserting the first cross yarn in the first insertion gap by conveying the insertion device trough the insertion gap;
Sixth step: handing over the first inserted cross yarn to a holding device;
Seventh step: providing a second cross yarn from a cross yarn supply;
Eight step: handing over the second cross yarn to an insertion device;
Ninth step: creating the second insertion gap;
Tenth step: aligning the insertion device with the second insertion gap;
Eleventh step: cutting off the second cross yarn from a cross yarn supply;
Twelfth step: inserting the second cross yarn in the second insertion gap by conveying the insertion device trough the insertion gap;
Thirteenth step: handing over the second inserted cross yarn to a holding device; and
Fourteenth step: connecting the inserted first and second cross yarn with each other to form the cross yarn loop.

[0044] In particular, one or more, in particular all, of the above steps are motor driven according to the process control sequence. In particular, the sequence of one or more of the above steps can be changed.

[0045] The above described fourteen steps have been previously described in more detail and are briefly described again in detail below so as to provide a quick overview of embodiments of the present method.

[0046] In particular, the first step of inserting the cross yarn loop into the axial yarns is conducted after stopping the delivery of the axial yarns. The first step particularly comprises providing a first cross yarn from a cross yarn supply.

[0047] Subsequently, in particular as the second step, an end section, in particular an open end section, of the first cross yarn is handed over to an insertion device, such as a carrier, in particular a rapier. Therefore, this second step particularly comprises grabbing in particular by a gripper device the end section of the first cross yarn and positioning the end section of the first cross yarn into a moving path of the carrier. Further, the second step particularly comprises moving the carrier along the moving path so that it picks up the end section of the first cross yarn.

[0048] Subsequently, in particular as the third step, a first insertion gap is created as described above. The creation of the insertion gap can particularly be initiated before or at the same time as the first and/or the second step or, as exemplary described here, subsequently to the second step.

[0049] Subsequently, in particular as the fourth step, the insertion device can be aligned with the created insertion gap. Therefore, the insertion device is in particular movably mounted in the same direction as the direction in which the first group of axial yarns and the second group of axial yarns are spaced from each other. The step of aligning the insertion device with the insertion gap is particularly necessary for embodiments of the invention in which the first insertion gap and the second insertion gap are formed in different positions, such as in different vertical positions.

[0050] Subsequently, in particular as the fifth step, the first cross yarn can be inserted into the first insertion gap by conveying the insertion device through the insertion gap. Thereby, the insertion device is in particular conveyed from an insertion gap inlet, in particular in the region of which the first cross yarn is handed over to the insertion device, to an insertion gap outlet.

[0051] Subsequently, in particular as a sixth step, the inserted first cross yarn can be handed over to a holding device. The holding device is in particular positioned in the region of the insertion gap outlet so as to receive the end section of the first cross yarn and to hold the cross yarn in its position at the insertion gap outlet while the insertion device can be driven back to the insertion gap inlet so as to receive the second cross yarn.

[0052] Subsequently, in particular as the seventh step, the second cross yarn can be provided from a cross yarn supply. In particular, the first cross yarn and the second cross yarn is provided from a single continuous cross yarn. Therefore, in particular before handing over the second cross yarn to an insertion device, a predetermined length of the second cross yarn is provided by winding the second cross yarn from a cross yarn supply. The predetermined length is in particular at least as long as the extension of the separate axial yarns in cross direction during the step of inserting the second cross yarn into the second insertion gap. As previously described, the step of providing the second cross yarn can be conducted simultaneously to one or more of the preceding steps, in particular to one more of the steps between the step of handing over the first cross yarn to an insertion device and the step of handing over the first inserted cross yarn to the holding device, in particular between the steps of inserting the first cross yarn into the first insertion gap and the step of handing over the first inserted cross yarn to a holding device.

[0053] Subsequently, in particular as the eight step, the second cross yarn can be handed over to the insertion device.

[0054] Subsequently, in particular as the ninth step, the second insertion gap is created.

[0055] Subsequently, in particular as the tenth step, the insertion device is aligned with the second insertion gap.

[0056] Subsequently, in particular as the eleventh step, the second cross yarn is cut from the cross yarn supply. Thereby, an open end section of the second cross yarn is formed which has to be connected with the open end section of the first cross yarn so as to form a closed cross yarn loop.

[0057] Subsequently, in particular as the twelfth step, the second cross yarn is inserted into the second insertion gap by conveying the insertion device through the second insertion gap.

[0058] Subsequently, in particular as the thirteenth step, the second inserted cross yarn is handed over to a holding device, in particular to a second holding device.

[0059] Subsequently, in particular as the fourteenth step, the inserted first and second cross yarns are connected with each other to form a cross yarn loop. In particular, open end sections of the first and of the second cross yarn are connected with each other at the insertion gap outlet in particular by means of splicing.

[0060] A second aspect of the invention relates to a station for forming a yarn rope, wherein the yarn rope comprises a bundle of axial yarns extending in axial direction and at least one cross yarn loop inserted in the bundle of axial yarns and extending in cross direction, the cross direction being orientated transversely, in particular perpendicularly, to the axial direction. The station comprises a shedding device for receiving a plurality of separate axial yarns and for creating an insertion gap confined between axial yarns and extending in cross direction, an insertion device for inserting a cross yarn in the insertion gap for forming under portions and over portions with respect to the axial yarns and a optionally a connecting device for forming said cross yarn loop by connecting inserted cross yarns, wherein the insertion device is driven by a motor.

[0061] In one embodiment, the insertion device comprises a carrier, in particular a rapier, being movable in cross direction in particular along the insertion gap. In particular the carrier is movable in that it can be driven through the first and/or section insertion gap. In particular the carrier is movably mounted, in particular movably guided in cross direction. Additionally or alternatively, the shedding device is driven by a motor. Additionally or alternatively, the shedding device and the insertion device are driven by separate motors. In particular, the motor is triggered by a control unit according to a process control sequence.

[0062] In particular, the station is designed such that it can conduct one or more, in particular all, of the steps being described with respect to the first aspect of the present invention. In particular, the method being described with respect to the first aspect of the present invention can be performed such that it can be executed with the station according to the second aspect of the present invention.

[0063] In particular, the shedding device can be configured to create a first and a second insertion gap. In particular, the insertion device can be configured to insert a first cross yarn and a second cross yarn into the first and the second insertion gap. In particular, the connecting device can be configured to connect the first and the second cross yarn with each other so as to form the cross yarn loop, in particular a closed cross yarn loop.

[0064] In particular, the insertion device can comprise a carrier, such as a rapier. The carrier can particularly be movably mounted along a carrier guidance in cross direction. In particular, the carrier guidance extends in cross direction along at least the entire extension of the axial yarns in the shedding device. In particular, the carrier is driven by a motor, in particular an electro motor. In particular, the motor drives a belt wheel which drives the carrier. In order to drive the carrier, the motor particularly drives the wheel which drives the belt. In particular, the belt is at one end connected with the carrier, in particular the rapier.

[0065] In particular, the station can be a cross yarn insertion station. In particular, the station can comprise a control unit being configured to drive the motor, in particular the separate motors, of the shedding device and/or of the insertion device in particular according to a process control sequence. The process control sequence can particularly comprise one or more of the previously described steps in particular in the previously described sequence.

[0066] In particular, the motor which drives the shedding device and the insertion device can be an electro motor. Alternatively, the motor can be a pneumatic or a hydraulic drive. In particular, the connecting device can be driven by a pneumatic or a hydraulic drive.

[0067] In one embodiment, the station can further comprise a cross yarn supply, such as a spool or a coil, for providing the cross yarn, wherein the cross yarn supply is preferably driven by a motor which is preferably triggered by a control unit according to a process control sequence. In particular, the control unit triggers the cross yarn supply to provide the insertion device with a continuous cross yarn of at least two times or at least three times the length of the extension of the plurality of axial yarns in the shedding device in cross direction. In particular, the cross yarn supply can be a polyester spool or coil. In particular, the cross yarn supply can be a spool or a coil with a longitudinal axis. In particular, the longitudinal axis of the spool or the coil extends in vertical direction so as to facilitate winding the cross yarn from the cross yarn supply. In particular, the spool or coil can be rotatably mounted around a rotational axis with respect to the station, wherein the rotational axis particularly extends in vertical direction so as to facilitate winding the cross yarn from the cross yarn supply. In particular, the cross yarn supply can be mounted above the insertion device. In particular, the station comprises a motor for winding the cross yarn from the cross yarn supply. In particular, the motor can be mounted between the yarn supply and the insertion device. In particular, the motor can drive a yarn drive, such as two roles, between which the cross yarn extends. In particular, the yarn drive can comprise two conveying means, such as rolls, being in contact with each other, in particular biased against each other, wherein the cross yarn extends through the contact region. In particular, the cross yarn can be clamped between the two conveying means, in particular between two rolls, so that the cross yarn can be winded from the

cross yarn supply by rotating the conveying means relative to each other, in particular by pulling the cross yarn from the cross yarn supply.

[0068] In one embodiment, the cross yarn loop being inserted according to the method of the first aspect of the invention and/or with the station according to the second aspect of the invention and/or into the bundle of axial yarns of the yarn rope according to the third aspect of the invention comprises or is made of thermoplastic and/or thermoset material, in particular polyester.

[0069] In particular, the control unit is configured to trigger the cross yarn supply to provide a first cross yarn by providing a first part of the continuous yarn and to provide a second cross yarn by providing a second part of the continuous cross yarn. In particular, the control unit is configured to provide the first cross yarn before the second cross yarn. In particular, the control unit is configured to provide the second cross yarn during the insertion of the first cross yarn into the first insertion gap. In particular, each of the first cross yarn and the second cross yarns are provided over a length of at least 100%, in particular at least 150%, of the extension of the plurality of axial yarns in the shedding device.

[0070] In one embodiment, the station further comprises a handling device for handing over the cross yarn to the insertion device, in particular for handing over the cross yarn from a yarn supply to the insertion device. In particular, the handling device is driven by a motor which is particularly triggered by a control unit in particular according to a process control sequence. The control unit particularly triggers the handling device. In particular, the handling device is a gripper device. In particular, the handling device is driven by an electro motor, a pneumatic motor and/or a hydraulic motor. In particular, the handling device comprises two clamps being configured to grab the end section of the first and/or second cross yarn. In particular the handling device is movable, in particular pivotable, in that it can position the cross yarn on a moving path of the insertion device along which the insertion device is movable in that it can pick up the cross yarn. In particular, the handling device is movably, in particular pivotably, mounted so that it can be moved from a clamping position into a handing over position. In particular, the clamping position and/or the handing over position are positioned such that the insertion device can move along the moving path without colliding with the insertion device. In particular, the cross yarn supply is configured to supply an end section of the cross yarn in between the clamps of the handling device so that the handling device can clamp the end section of the cross yarn between the clamps. In particular, the handling device is configured to position the end section of the cross yarn in the handing over position into a moving path of the insertion device. In particular, the insertion device is configured to pick up the end section of the cross yarn upon moving along the moving path.

[0071] In one embodiment, the handling device comprises two clamps for grabbing the cross yarn, in particular open end section, in a clamping position, wherein the handling device comprises two guiding wings confining a guiding path between a yarn supply and the clamps in the clamping position. In particular, the guiding wings confine a v-shaped guiding path expanding in particular in the clamping position towards the yarn supply. Additionally or alternatively, the guiding wings are shaped as male part to a recess in a coat confining a yarn outlet, in particular in that the guiding wings and the coat are in contact with each other and confine a particularly half cylindrical guiding channel between the yarn supply and the clamps in the clamping position.

[0072] In particular, the yarn outlet has a substantially half cylindrical shape. In particular, the yarn outlet is confined by a substantially half cylindrical coat. In particular, the longitudinal axis of the half cylindrical coat extends in spacing direction, in particular in vertical direction. In particular, the open side of the half cylindrical shape, in particular coat, faces the handling device. In particular, the term substantially with regard to the half cylindrical shape can be understood in that the yarn outlet deviates from a half cylindrical shape by a particularly curved recess.

[0073] In one embodiment, the handling device comprises two guiding wings. In particular, the guiding wings confine a v-shaped guiding path in particular for guiding the cross yarn, in particular open end section, from the yarn supply, in particular from the yarn outlet, to a position between the two clamps of the handling device. In particular, the guiding wings are inclined to each other in that the v-shaped guiding path expands towards the yarn supply, in particular yarn outlet, in particular in the clamping position. Thereby, it can in particular be ensured that the end section being provided from the yarn supply is reliably positioned between the clamps of the handling device. In particular, the side of the guiding wings facing the yarn supply, in particular the yarn outlet, are shaped as male part of the particularly curved recess of the yarn outlet so that the guiding wings can fill out the recess in a contacting clamping position. It has been found advantageous to bring the guiding wings into a contacting clamping position before providing, in particular conveying, the end section of the cross yarn towards the handling device. In particular, the guiding wings and the recess of the yarn outlet are designed in that the guiding wings and the yarn outlet build a half cylindrical guiding channel in the contacting clamping position in particular along which the cross yarn can reliably be guided from the cross yarn supply to a position between the clamps. In particular, the guiding wings and the recess of the yarn outlet are arch shaped. This particularly enables bringing the handling device from the handing over position into the contacting clamping position and vice versa by pivoting the handling device in particular without colliding with the yarn outlet before reaching the contacting clamping position.

[0074] In one embodiment, the station further comprises a positioning device for aligning the insertion device

with an insertion gap formed by the shedding device. In particular, the positioning device is configured to move the insertion device into the same direction in which the shedding device spaces the axial yarns to each other for forming the first and/or second insertion gap. In particular, the positioning device comprises at least one, preferably two, cylinder for aligning the insertion device with the insertion gap. In particular, the longitudinal axis of the cylinder extends in spacing direction. In particular, the positioning device is configured to move the insertion device in vertical direction. In particular, the positioning device is driven by a motor which is in particular triggered by a control unit in particular according to a process control sequence. In particular, the insertion device is coupled to a connecting device, a handling device, a cutting device, a holding device and/or a yarn supply in such a way that aligning the insertion device with the insertion gap causes a displacement of the insertion device and of the connecting device, handling device, cutting device, holding device and/or yarn supply to the same extend and/or in the same direction as the insertion device. In particular, the insertion device comprises a carrier being movably mounted along a carrier guidance in cross direction. In particular, the carrier guidance is fixedly mounted with a support structure being movable by the positioning device. In particular, the support structure is a bar. In particular, the support structure extends in cross direction at least over the entire extension of the axial yarns within the shedding device. In particular, the support structure extends in cross direction at least from the insertion device to the connecting device and/or the holding device. In particular, the connecting device, a handling device, a cutting device, a holding device and/or a yarn supply is fixedly connected with the support structure.

[0075] In one embodiment, the station further comprises a holding device for holding at least one, particularly at least two, inserted cross yarns. In particular, the holding device is driven by a motor. In particular, the motor is triggered by a control unit in particular according to the process control sequence. In particular, the holding device comprises two clamps being movable relative to each other. In particular the insertion device is movably mounted in such a way that it can insert the end section of the first and/or second cross yarn in between the two clamps of the holding device. In particular, the insertion device is therefore movably mounted along the carrier guidance which extends in cross direction through a gap between the two clamps of the holding device. In particular, the control unit triggers the insertion device to pass through the holding device, so that a trailing end section of the first and/or second cross yarn extends through the gap between the two clamps. In particular, the control unit is configured to trigger the holding device to clamp the end section of the first and/or the second cross yarn in between the clamps in particular after the carrier has passed through the gap of the two clamps. In particular, after the end section of the first and/or second cross yarn is clamped between the two clamps of the holding device, the control unit is configured to trigger the insertion device to drive back to an insertion gap inlet. In particular, the station comprises two holding devices. In particular, one or both of the holding devices is mounted in cross direction behind the insertion gap outlet and in particular behind the connecting device.

[0076] In one embodiment, the station comprises a cutting device for cutting off the cross yarn from the cross yarn supply, wherein the cutting device is preferably driven by a motor which is preferably triggered by a control unit according to the process control sequence. In particular, the cutting device is an air cutter. In particular the motor is a pneumatic drive driving the cutter device. In particular, the control unit is configured to trigger the cutting device to cut off the second cross yarn from the cross yarn supply after an end section of the second cross yarn has been handed over to the insertion device. In particular thereby, the end section of the second cross yarn becomes an open end section. In particular, the connecting device is arranged in cross direction between at least one, preferably two, holding device and the shedding device.

[0077] In particular, the connecting device is a splicer, in particular a pneumatically driven splicer. In particular, the splicer comprises a pneumatic outlet for subjecting two end sections of the first and/or the second cross yarn with compressed gas, in particular with compressed air, so as to entangle the end sections with each other by splicing. In particular, the connecting device can comprise a heat exchanger for heating the gas so as to combine the effect of connecting due to intermingling with the effect of connecting due to melting. In particular, the effect of connecting due to melting has been found to be particularly advantageous when using thermoplastic and/or thermoset, in particular polyester, cross yarns.

[0078] In one embodiment, the station comprises a tracking device, such as a sensor or a counter, for tracking predetermined process states, such as predetermined time intervals and/or predetermined yarn rope lengths being formed. In particular, a control unit is configured to initiate the insertion of the cross yarn loop according to the process control sequence upon receiving the predetermined process states from the tracking device. In particular, the tracking of the predetermined yarn rope length being formed and/or the initiation of the cross yarn loop insertion is realized as described with respect to the previously described method.

[0079] In one embodiment, the station comprises a bundling station for bundling the separate axial yarns with the inserted cross yarn loop to a rope. Additionally or alternatively, the station comprises a rope warping machine for winding the rope on a bobbin. In particular, the bundling station is arranged downstream the shedding device. In particular, the bundling station comprises a roll with a guiding recess for receiving the axial yarns. In particular, the guiding recess is U-shaped or V-shaped. In particular, the roll can be rotatable mounted. In particular,

the rope warping machine is arranged downstream the bundling station and/or downstream the shedding device. In particular, the rope warping machine comprises a bobbin being driven around a bobbin axis so as to helically wind the formed rope around the bobbin axis.

[0080] According to one embodiment, the station comprises a control unit being configured to trigger the insertion of the cross yarn loop according to one or more of the following steps according to the following process control sequence:

First step: triggering the cross yarn supply to provide a first cross yarn;
Second step: triggering the handling device to hand over the first cross yarn to the insertion device;
Third step: triggering the shedding device to create the first insertion gap confined by the axial yarns and extending in cross direction;
Fourth step: triggering the positioning device to align the insertion device with the insertion gap;
Fifth step: triggering the inserting device to insert the cross yarn in the insertion gap for forming first under portions and over portions with respect to said axial yarns;
Sixth step: triggering the holding device to hold the inserted first cross yarn;
Seventh step: triggering the cross yarn supply to provide a second cross yarn;
Eight step: triggering the handling device to hand over the second cross yarn to the insertion device;
Ninth step: triggering the shedding device to create the second insertion gap confined by the axial yarns and extending in cross direction;
Tenth step: triggering a positioning device to align the insertion device with the second insertion gap;
Eleventh step: triggering the cutting device to cut off the second cross yarn from the yarn supply;
Twelfth step: triggering the inserting device to insert the second cross yarn in the second insertion gap for forming second under portions and over portions with respect to said axial yarns;
Thirteenth step: triggering the holding device to hold the inserted second cross yarn; and
Fourteenth step: triggering the connecting device to form the cross yarn loop by connecting the inserted cross yarns with each other.

[0081] In particular, triggering can include driving a motor, such as an electro motor, a pneumatic motor or a hydraulic motor, for driving one or more of the above devices for conducting the respective step. In particular, the station comprises an electro motor for driving the cross yarn supply. In particular the station comprises one single cross yarn supply for providing the first and the second cross yarn. In particular the station comprises one single insertion device for inserting the first and the second cross yarn into the first and the second insertion gap. In particular, the station comprises a pneumatic motor, in particular a pneumatic drive, for driving the handling device, in particular for driving the clamps of the handling device. Alternatively or additionally, the station comprises an electro motor for driving the handling device, in particular for moving the handling device from a clamping position to a handing over position. In particular, the station comprises a single handling device for handing over the first cross yarn and the second cross yarn to the insertion device. In particular, the station comprises a pneumatic motor, in particular a pneumatic drive, for driving the shedding device. In particular, the station comprises two motors, in particular two pneumatic drives, each of which is connected with one of two shafts of the shedding device for driving the two shafts independently from each other. In particular, the station comprises one motor, in particular one pneumatic drive, for driving the positioning device. In particular, the station comprises two cylinders, in particular pneumatic cylinders, for driving the positioning device. In particular, the station comprises a motor, in particular a pneumatic drive, for driving the holding device. In particular, the station comprises two holding devices for holding the first and the second inserted cross yarn. In particular, the station comprises two motors, in particular two pneumatic drives, for driving the holding devices. In particular, the station comprises a motor, in particular a pneumatic drive, for driving the cutting device. In particular, the station comprises a motor, in particular a pneumatic drive, for driving the connecting device, in particular the splicer.

[0082] In particular, the cutting device and the yarn supply are configured to provide with one cut an open end section for a second cross yarn of a cross yarn loop being currently inserted into the axial yarns and an open end section of a first cross yarn of a subsequent cross yarn loop to be inserted into the axial yarns in particular at a predetermined process state.

[0083] According to a third aspect of the invention, a yarn rope is provided comprising a bundle of axial yarns extending in an axial direction and at least one cross yarn loop inserted in the bundle of axial yarns and extending in a cross direction, the cross direction being orientated transversely, in particular perpendicularly, to the axial direction, wherein the cross yarn loop comprises two cross yarn end sections being connected with each other by splicing.

[0084] In particular, the cross yarn loop is formed from one continuous cross yarn. In particular, the cross yarn loop is formed from one single yarn, in particular in that the cross yarn loop comprises only one connecting section in which the two cross yarn end sections are connected with each other. In particular, the two cross yarn end sections are the end sections of the continuous cross yarn. In a less preferred embodiment the cross yarn loop can be formed from two separate cross yarns each of which comprises two cross yarn end sections. In such an embodiment, each of the two cross yarn end sections of one cross yarn can be connected with respectively one cross yarn end section of the other cross yarn. In partic-

ular one or both of these connections can be realized by splicing.

[0085] In particular, the cross yarn end sections are connected with each other by exposing the end sections with compressed gas, in particular compressed air, so as to entangle the end sections with each other. In particular, the cross yarn end sections comprise a plurality of filaments being entangled with each other in particular due to the connection via splicing. In particular, the cross yarn end sections are spirally wound around each other in particular by due to the connection via splicing. In particular, the cross yarn end sections are entangled and/or spirally wound around each other along a connecting section in particular along at least 1 mm, 2 mm, 3 mm, 5 mm, 7 mm, 10 mm, 15 mm or 20 mm and comprise gripping sections in particular behind that connecting length. In particular, the gripping sections extends along at least 1 mm, 2 mm, 3 mm, 5 mm, 7 mm, 10 mm, 15 mm or 20 mm, 25 mm, 30 mm or 50 mm. In particular, the connecting sections extends in between the cross yarn loop and the gripping sections. In particular, the gripping sections of the cross yarn end sections are not entangled and/or spirally wound around each other. In particular, the compressed gas can be heated so that the end sections of the cross yarns are in addition connected with each other due to melting. In particular, the cross yarn loop is a thermoplastic or thermoset yarn. In particular, the cross yarn loop is a polyester yarn.

[0086] In particular, the yarn rope can is formed with the method according to the first aspect of the present invention and/or with the station according to the second aspect of the present invention. In particular, the method according to the first aspect of the present invention can be performed so as to enable the formation of a yarn rope according to the third aspect of the present invention. In particular, the station according to the second aspect of the present invention can be configured to enable the formation of a yarn rope according to the third aspect of the present invention.

[0087] Preferred embodiments of the invention are described in the dependent claims. Further advantages, features, and characteristics of the invention become apparent by the subsequent description of the preferred embodiments which are illustrated in the figures, wherein:

Fig. 1 is a schematic cross-sectional view on a plurality of separate axial yarns;

Fig. 2 is a schematic view on the axial yarns in Fig. 1 confining a first insertion gap, wherein a first cross yarn is inserted into the first insertion gap;

Fig. 3 is a schematic view on the axial yarns in Fig. 2 confining a second insertion gap, wherein a second cross yarn is inserted into the second insertion gap;

Fig. 4 is a schematic view on the axial yarns in Fig. 3, wherein the cross yarn end sections are connected with each other;

Fig. 5 is a schematic view on the axial yarns in Fig. 4, wherein the axial yarns are bundled;

Fig. 6 is a perspective view on an exemplary embodiment of a station for forming a yarn rope;

Fig. 7 is a front view on the station shown in figure 6;

Fig. 8 is a side view on the station shown in figure 6;

Fig. 9 is a top view on the station shown in figure 6;

Fig. 10 is an enlarged view on the insertion device, a yarn supply and a handling device shown in figure 6;

Fig. 11a is a front view on an insertion device, a yarn supply, a handling device and a cutting device according to a modified embodiment of the station compared to figures 7 to 10 and 12 showing the handling device in the clamping position;

Fig. 11b is a front view of the embodiment according to figure 11a showing the handling device in the handing over position;

Fig. 11c is a perspective view of the embodiment of figure 11b and 11a showing the handling device in the handing over position;

Fig. 11d is a perspective view of the embodiment of figure 11b to 11c showing the insertion device inserting the cross yarn in the insertion gap;

Fig. 12 is an enlarged view on the holding devices and the connecting device shown in figure 6;

[0088] For an easier legibility, similar or the same components are designated in the following with similar or the same reference signs.

[0089] For the following description, the axial direction is designated with the reference sign A, the cross direction is designated with the reference sign C and the spacing direction is designated with reference sign S.

[0090] The figures 1 to 5 illustrate schematically separate axial yarns 1, 3 in a cross-sectional view. Separate means that the axial yarns 1, 3 are separated in cross direction C. The separate axial yarns 1, 3 extend in a plane extending in cross direction C and in axial direction A. As can be seen from the figures 6 and 7, the separate axial yarns 1, 3 are received by a shedding device 5. The shedding device 5 defines the space 9 between the axial

yarns 1, 3 in cross direction C. The space 9 between the axial yarns 1, 3 in cross direction C is in particular defined by the space between the dents or heddles of the shedding device 5 extending in spacing direction S.

[0091] Figure 2 illustrates a process state in which a first insertion gap being confined by the axial yarns 1, 3 is created. The first insertion gap is created by spacing a first group of axial yarns 1 relative to a second group of axial yarns 3. The dashed line 11 in the figures 1 to 4 indicates a constant position in spacing direction S. As can be seen from figure 2, the first insertion gap can be created by displacing the first group of axial yarns 1 relative to the second group of axial yarns 3. In this example, the second group of axial yarns 3 is not displaced for forming the first insertion gap. The first insertion gap is confined between the first group of axial yarns 1 and the second group of axial yarns 3 in spacing direction S. The first insertion gap extends as a channel in cross direction C. Figure 2 further illustrates schematically a process state in which a first cross yarn 13 has been inserted into the first insertion gap and in which a second cross yarn 15 has been provided from a cross yarn supply 17.

[0092] The first cross yarn 13 has been inserted into the first insertion gap in that first over portions 33 and first under portions 35 are formed with respect to the axial yarns 1, 3. With respect to the first group of axial yarns 1, first under portions 35 of the first cross yarn 13 are formed. With respect to the second group of axial yarns 3, first over portions 33 of the first cross yarn 13 are formed. As can be seen from figure 2, the terms over portion and under portion relate to the relative position of sections of the cross yarn in spacing direction relative to the axial yarns 1, 3.

[0093] The first cross yarn 13 and the second cross yarn 15 are provided from a continuous cross yarn. The first cross yarn extends from an open and section 19 of the first cross yarn 13 to a closed end section 21 of the first cross yarn 13. The second cross yarn 15 extends from a closed end section 23 to a closed end section 25. The difference between an open end section and a closed end section can be seen in figure 2. Namely, an open end section, such as the open end section 19 of the first cross yarn 13, comprises the end of a yarn, in this case the end 27 of the first cross yarn 13 and the end 27 of the continuous cross yarn. Contrary thereto, a closed end section of a yarn merges continuously into another yarn. In the example shown in figure 2, the closed end section 21 of the first cross yarn merges continuously into the closed end section 23 of the second cross yarn 15 and the close end section 25 of the second cross yarn 15 merges continuously into a continuous cross yarn 29 being wound around the spool of the cross yarn supply 17.

[0094] In figure 3, a process step is schematically illustrated in which a second insertion gap has been formed, the closed and section 25 of the second cross yarn has been cut from the continuous cross yarn 29 of the cross yarn supply 17 and the second cross yarn 15 has been inserted into the second insertion gap. Upon cutting the closed end section 25 of the second cross yarn from the continuous cross yarn 29, the closed end section 25 of the second cross yarn has been transferred into an open end section 25' with an end 31 of the second cross yarn 15. Contrary thereto, the closed end sections 21 and 23 of the first and second cross yarn 13, 15 remain closed end sections which continuously merge into each other.

[0095] As can be seen from figure 2 and figure 3, the insertion of the first cross yarn 13 and the insertion of the second cross yarn 15 into the first and the second insertion gap can be realized by conveying the first cross yarn 13 and the second cross yarn 15 from an insertion gap inlet 45 of the first and the second insertion gap to an insertion gap outlet 47 of the first and the second insertion gap. As shown in figure 3, the insertion gap inlet 45 of the first insertion gap and the insertion gap inlet 45 of the second insertion gap can be located on the same side of the first and the second insertion gap in cross direction C. Further, the insertion gap outlet 47 of the first insertion gap and the insertion gap outlet 47 of the second insertion gap can be located on the same side of the first and second insertion gap in cross direction C.

[0096] As indicated by the dashed line 11, the second group of axial yarns 3 has not been displaced upon creating the second insertion gap. However, the first group of axial yarns 1 has, compared to the displacement for forming the first insertion gap, been displaced into the opposite direction relative to the second group of axial yarns 3. Thereby, a second insertion gap has been created in which the first over portions 33 and the first under portions 35 bypass the axial yarns 1, 3 outside of the second insertion gap. As can be seen from figure 3, this leads to the effect that the second over portions 37 and the second under portions 39 of the second cross yarn 15 are formed in that, with respect to one axial yarn 3, an over portion 33 of the first cross yarn 13 is followed in axial direction by a second under portion 39 of the second cross yarn 15 and vice versa. As can be seen from figure 4, this leads to the effect that each of the axial yarns 1, 3 is enclosed, in particular encircled, by an over portion 33, 37 and an under portion 35, 39.

[0097] The axial yarns of the first group of axial yarns 1 are encircled by first under portions 35 and second over portions 37. The axial yarns of the second group of axial yarns 3 are encircled by first over portions 33 and second under portions 39. Figure 4 illustrates a process state in which the open and sections 19 and 25'of the first cross yarn 13 and the second cross yarn 15 have been connected with each other so that a cross yarn loop is formed. Thereby, the open end sections 19 and 25' have been transferred into closed end sections merging continuously into each other. As can be seen from figure 4, a cross yarn loop is a closed structure being free of open end sections. In figure 4, the first group of axial yarns 1 has been displaced again onto the same height in spacing direction S as indicated by the dashed line 11.

[0098] Figure 5 illustrates a process state in which the

insertion of the cross yarn loop 41 into the axial yarns 1, 3 has been completed and in which the axial yarns have been bundled into a yarn rope 43. Due to the encirclement of the axial yarns 1, 3 by the over portions 33, 37 and the under portions 35, 39 of the first cross yarn 13 and the second cross yarn 15, the axial yarns 1, 3 can be rearranged from the rope form into an arrangement in which the axial yarns 1, 3 extend in a plane, such as shown in figure 1 and figure 4. In this form, the axial yarns 1, 3 can be threaded into a reed, such as a read of a weaving machine. As can be seen from figure 5, the inserted cross yarn 41 extends in the yarn rope 43 in cross direction C and in spacing direction S.

[0099] Figure 6 shows a perspective view on a station 51 for forming a yarn rope 43. Figure 7 illustrates a front view on the station of figure 6. Figure 8 shows a side view on the station of figure 6. Figure 9 shows a top view on the station of figure 6. Figure 10 shows an enlarged view on the insertion device, a yarn supply and a handling device shown in figure 6. Figures 11a to 11d show a modified embodiment of an insertion device, a yarn supply, a handling device and a cutting device in different process states. Figure 12 shows an enlarged view on the holding devices and the connecting device shown in figure 6.

[0100] As indicated in figure 9, the plurality of separate axial yarns 1, 3 are received by the station 51 and extend through the station 51 in axial direction A. The station is preferably arranged in axial direction A upstream a not shown bundling station for bundling the separated axial yarns 1, 3 including the inserted cross yarn loop 41 into a yarn rope 43 as schematically shown in figure 5. Further, the station 41 is preferably arranged in axial direction A downstream a not shown station for forming the plurality of axial 1, 3 yarns and for delivering the axial yarns to the station 51. The plurality of axial yarns 1, 3 are received by the shedding device 5.

[0101] The shedding device 5 being illustrated in figure 6 is a shedding device creating the first and the second insertion gap by displacing a first group of axial yarns 1 relative to a second group of axial yarns 3 in spacing direction S. Therefore, the shedding device 5 comprises a not shown shaft with a plurality of heddles extending in spacing direction. The axial yarns of the first group of axial yarns are threaded through eyes of the heddles so that displacing the shaft in spacing direction forces the first group of axial yarns to follow the movement of the shaft. The second group of axial yarns can also be threaded through a shaft with heddles so as to additionally displace the second group of axial yarns relative to the first group of axial yarns. However, it has been found that the second group of axial yarns can also be received by a non-movable reed like structure 53 confining the second group of axial yarns 3 in channels being formed by a plurality of dents 55 extending in spacing direction S and being spaced from each other in cross direction C. The plurality of dents 55 are connected with two bars 57 extending in cross direction C and being spaced from each other in spacing direction S. In particular, the bars 57 and the dents 55 confine channels for the separate axial yarns so as to keep the axial yarns separated during the insertion of the cross yarn loop 41. The previously described shaft for displacing the first group of axial yarns can be integrated into this reed like 53 structure or can be arranged upstream or downstream the reed like structure 53. Figure 8 illustrates a process state in which the first group of axial yarns 1 is spaced from the second group of axial yarns 3 by lifting the first group of axial yarns 1 relative to the second group of axial yarns 3 in spacing direction S. As can be seen in figure 8, the insertion gap extends thereby in cross direction C and is confined by the first group of axial yarns 1 and the second group of axial yarns 3 in spacing direction S and in axial direction A.

[0102] The shedding device 5 is mounted to a support structure 59 on a vertical position for enabling a person to survey the cross yarn loop insertion. Particular, the shedding device is mounted on a vertical position between 0.5 meter and 2,0 meter, in particular between 0,8 meter and 1,5 meter.

[0103] Downstream the shedding device 5 in axial direction A, the station comprises an insertion device 61 for inserting the first cross yarn 13 and the second cross yarn 15 into the insertion gaps being created by the shedding device 5. As can be best seen in the figures 6 and 7, the insertion device is mounted on a positioning device 63 for aligning the insertion device 61 with an insertion gap formed by the shedding device 5. The positioning device 63 comprises two stands 65 extending in spacing direction S and being spaced from each other in cross direction C. In between the two stands 65 in cross direction C, the positioning device comprises a support structure 67, in particular in form of a bar, extending in cross direction C. The support structure 67 is movably mounted relative to the two stands 65 by a linear guidance 69. The support structure 67 can be displaced in spacing direction S by two linear drives 71 being oriented in spacing direction S so as to displace the support structure 67 in spacing direction S. The linear drives 71 are fixedly connected with the stands 65 and with the support structure 67. The insertion device 61 is mounted on the support structure 67. Thereby, the insertion device 61 follows a displacement of the support structure 67 in spacing direction S.

[0104] In addition to the insertion device 61, also the connecting device 73, the holding devices 75, the handling device 77, the cutting device 115, and the yarn supply 17 are mounted on the support structure 67. Thereby, the previously named devices follow the displacement of the support structure 67.

[0105] The implementation of a positioning device 63 has been found to be particularly advantageous in combination with a shedding device 5 using only one movable shaft. Due to the usage of only one movable shaft, the first insertion gap and the second insertion gap can extend on different positions in spacing direction S. Due to the implementation of the positioning device 63 a single

insertion device 61 can be used for inserting cross yarns into the first and the second gap even if they extend in different positions in spacing direction S.

[0106] Exemplary embodiments of the insertion device 65, the yarn supply 17 and the handling device 77 are now described in more detail with respect to figure 10 and figures 11a to 11d.

[0107] In figure 10, the cross yarn supply comprises a cross yarn spool 79 being rotatably mounted on a support structure 71 of the cross yarn supply 17. The cross yarn spool 79 is rotatably mounted around a rotational axis 97. The support structure 81 comprises a stand 83 and a spool cage 85. The spool cage 85 has a cylindrical shape. The spool cage 85 is connected to the stand 83 with its lateral side. The stand 83 is connected with the support structure 67 of the positioning device 63. The spool cage comprises a handle 87. The handle 87 is mounted on the top of the spool cage 85. In particular on the bottom of the spool cage 85 in displacement direction, the spool cage comprises a yarn outlet 90, in particular a yarn supply outlet 90, for guiding a continuous cross yarn 29 to a yarn drive 89. The yarn drive 89 serves for winding the continuous cross yarn 29 from the cross yarn spool 79. The yarn drive 89 comprises two conveying means 91, such as rolls, which are driven by a motor 99, such as an electro motor. The continuous cross yarn 29 can be clamped between the conveying means 91 in form of rolls so that driving the rolls winds the continuous cross yarn 29 from the yarn supply 17 and delivers it to the handling device 77 below the yarn drive 89. The station 51 further comprise a cutting device 115 in form of a pneumatic cutter, in particular an air cutter, which is mounted between the cross yarn supply 17 and the handling device 77. The cross yarns 13, 15 are conveyed from the yarn supply through the yarn drive 89 of the cross yarn supply to the cutting device 115 where it leaves the cutting device through a yarn outlet, in particular a cutting device outlet 101.

[0108] An embodiment of the yarn outlet 101 and of the cutting device 115 can be seen in more detail in figures 11a to 11d. Therein, the cutting device 115 is mounted in between the cross yarn supply 17 and the yarn outlet 101. In figures 11a to 11d, the components of the cross yarn supply are hidden by a cross yarn supply coat 125 which secures its components from dust, heat and unintended intervention by persons. The yarn outlet 101 has a substantially half cylindrical shape in particular extending in spacing direction S, in particular vertical direction. The open side of the half cylindrical shape faces the handling device 77. The term substantially with regard to the half cylindrical shape can be understood in that the cutting device outlet 101 deviates from a half cylindrical shape by a curved recess 127. A catch frame 129 is spaced from the cutting device outlet 101 in vertical direction to ensure that open end sections of the cross yarn leaving the yarn outlet remain in a position where they can be clamped between two clamps 93 of the handling device 77. The catch frame 127 can be a closed frame, such as the circular frame shown in figure 10, or an open frame, such as the horseshoe frame shown in figures 11a to 11d.

[0109] From the cutting device outlet 101, the cross yarns 13, 15 can be handed over to the insertion device 65 by the handling device 77.

[0110] The handling device 77 serves to hand over the continuous cross yarn 29 being provided by the cross yarn supply 17 to the insertion device 65. Therefore, the handling device 77 comprises two clamps 93 being configured to grab the end section 19, 25 of the first cross yarn 13 and the second cross yarn 15 being provided by the cross yarn supply. The clamps 93 are pneumatically driven so as to open or close a space between the clamps 93. The clamps 93 are mounted relative to the yarn supply 17 in that, in the clamping position shown in figure 11a, the end section 19, 25 of the cross yarn 13, 15 is provided in between the space of the two clamps 93. Upon closing the space between the two clamps 93, the end section 19, 25 of the cross yarn is grabbed by the clamps 93. The handling device 77 is pivotably mounted so as to move the handling device from the clamping position into a handing over position. The handling device 77 is driven by a motor in form of the electro motor 117 which enables pivoting the handling device from the clamping position into the handing over position and vice versa. In figure 10 and figures 11b and 11c, the handling device 77 is illustrated in the handing over position. In the handing over position, the end section 19, 25 of the cross yarn is positioned into a moving path of the carrier in form of a rapier 95 of the insertion device 65. After pivoting the handling device 65 into the handing over position, the motor 99 of the cross yarn supply 17 can be driven in that the end section 19, 25 becomes straightened, in particular stretched, between the clamps 93 of the handling device 77 and the yarn outlet 101 of the cutting device 115 as shown in figure 10. Upon moving the rapier 95 along the moving path, the rapier 95 picks up the end section 19, 25 of the cross yarn as shown in figure 11c.

[0111] The handling device 77 and the step of handing over the end section 19 of the first cross yarn to the insertion device is described in more detail with reference to figures 11a to 11d. Figure 11a shows the handling device 77 in a clamping position. In this clamping position, the clamps 93 of the clamping device are positioned in that a cross yarn 13 extending from the yarn outlet 101 straight downwards in gravitational direction in particular towards the catch frame 129 is located between the two clamps 93. The embodiment shown in figures 11a to 11d with open catch frame 129 enables that the clamps 93 can be positioned in between the catch frame 129 which increases the reliability with which end section 19 of the first cross yarn can be clamped in between the clamps 93. As can be seen in figure 11a, the handling device 77 can comprise two guiding wings 133. The guiding wings confine a v-shaped guiding path extending in the clamping position between the yarn outlet 101 and the clamps 93. The guiding wings are inclined relative to each other

in that the v-shaped guiding path expands in the clamping position towards the yarn outlet 101. Thereby, it can be ensured that the end section being provided from the yarn supply is reliably positioned between the clamps of the handling device. The side of the guiding wings 133 facing the yarn outlet 101 are shaped as male part of the curved recess 127 so that the guiding wings 133 can fill out the curved recess 127 in a contacting clamping position. The clamping position shown in figure 11a shows a clamping position shortly before reaching the contacting clamping position. As can be seen from figure 11a, clamping the cross yarn 13 between the clamps 93 of the handling device 77 can also be realised outside the contacting clamping position. However, it has been found advantageous to bring the guiding wings 133 into the clamping position before providing, in particular conveying, the cross yarn 13 towards the handling device 77. In the contacting clamping position, the guiding wings 133 and the yarn outlet 101 build a half cylindrical guiding channel along which the cross yarn can reliably be guided from the cross yarn supply 17 in between the clamps 77.

[0112] As can be seen in figure 11a, the guiding wings 133 and the recess of the yarn outlet 101 are preferably arch shaped. This enables bringing the handling device from the handing over position into the contacting clamping position and vice versa by pivoting the handling device 77 without colliding with the yarn outlet 101 before reaching the contacting clamping position.

[0113] Figures 11b and 11c illustrate the handling device 77 in the handing over position. In order to reach the handing over position, the handling device 77 is pivoted about a pivot axis 135. The pivot axis 135 is mounted in gravitational direction below the yarn outlet 101 and bellow the catch frame 129. In axial direction A, the insertion device 61 is located between the pivot axis and the yarn outlet 101. Figure 11b and 11c illustrate the insertion device 61 after the rapier 95 has been moved along the moving path and thereby picked up the end section 19, 25 of the cross yarn. As previously described, before moving the rapier 95 along the moving path for picking up the end section 19, 25, the motor 99 of the cross yarn supply 17 was driven in that the end section 19, 25 becomes straightened between the clamps 93 of the handling device 77 and the yarn outlet 101.

[0114] Figure 11d illustrates a process stage in which the rapier 95 has already partially inserted the first cross yarn 13 into the first insertion gap.

[0115] The moving path of the rapier 95 for picking up the end section 19, 25 of the cross yarn is aligned with the insertion path of the rapier 95 for inserting the cross yarn 13, 15 into the insertion gap.

[0116] The moving path and the insertion path of the rapier 95 are defined by a rapier guidance extending in cross direction C. The rapier guidance comprises a guiding bar 103 upstream the handling device 77 in cross direction C and a guiding bar 105 downstream the handling device 77 in cross direction C. The guiding bars 103 and 105 are aligned so that the moving path and the insertion path extend collinear with each other. The guiding bars 103, 105 comprise a guiding recess in which the rapier 95 is guided in cross direction C. The guiding bars 103, 105 are mounted to the support structure 67 of the positioning device 63. The guiding bars 103, 105 are mounted via two stands 107 to the support structure 67 so that the guiding bars 103, 105 are positioned in spacing direction S above the support structure 67. The rapier 95 is connected with a belt 109 which is driven by a wheel 111. The belt 109 is guided within the guiding bars 103 and 105 and around the wheel 111. The belt 109 comprises recesses 131 or a toothing being adapted to recesses or a toothing of the wheel 111 so as to be driven by a rotation of the wheel 111. The wheel 111 is driven by a motor 113 in form of an electro motor. The wheel 111 and the motor 113 are mounted on the support structure 67. The wheel 111 is positioned relative to the guiding bar 103 in that the belt 109 continuously merges from the radial outside of the wheel 111 into the groove of the guiding bar 103. Thereby, upon driving the wheel 111 by the motor 113, the rotational movement of the belt 109 is transferred to a linear movement along the guiding bar 103 and subsequently along the guiding bar 105. The guiding bar 103 and the guiding bar 105 are spaced from each other in cross direction C on the high of the handling device 77 so as to enable the handing over of the cross yarn to the rapier 95. The belt 109 is designed stiff enough to drive the rapier 95 along the guiding bars 103 and 105 and flexible enough to be wound around the wheel 111.

[0117] Upon driving the motor 113 of the guiding device 65, the wheel 111 rotates and thereby drives the belt 109 which drives the rapier 95 first along the moving path so as to pick up the end section 19 of the first cross yarn. Subsequently, the rapier is driven from an insertion gap inlet 45 to an insertion gap outlet 47 of the first insertion gap being formed by the shedding device 5 where the end section 19 of the first cross yarn 13 is handed over to the holding device 75. Subsequently, the rapier 95 is driven back to its starting position by driving the motor 113 in reverse direction. Subsequently, the second cross yarn 15 is provided by driving the yarn supply 17 with the motor 99 of the yarn supply. Subsequently, a closed end section 25 of the second cross yarn 15 is handed over to the rapier 95 as previously discussed with respect to the first cross yarn 13. However, before inserting the second cross 15 yarn into the second insertion gap, the closed end section 25 of the second cross yarn is transferred into an open and section 25' by cutting the end section 25 from a continuous cross yarn 29 of the yarn supply 17. The step of cutting the end section 25 of the second cross yarn 15 from the continuous cross yarn 29 of the yarn supply 17 is conducted by a cutting device in form of an air cutter 115. Subsequently, the second cross yarn 15 is inserted into the second insertion gap as previously described and subsequently handed over to the holding device 75.

[0118] The holding device and the connecting device are now described in more detail with respect to figure 11.

[0119] The station 51 comprises two holding devices 75. Each holding device comprises to clamps 119 which are driven by a pneumatic drive for opening and closing a space between the clamps 119. In order to hand over an end section 19, 25' to a holding device 75, the clamps 119 of the holding device are spaced from each other so as to enable the rapier 95 to bypass the holding device 75 in that the end section 19, 25' of the cross yarn 13, 15 extend through the space between the clamps 119. Subsequently, the space between the clamps is closed by triggering the pneumatic drive so that the end section 19, 25' is grabbed by the holding device 75. Subsequently, upon driving the rapier 95 back to the insertion gap inlet, the end section 19, 25' is released from the rapier and remains in the holding device 75. After both end sections 19, 25' have been handed over to the holding devices 75, the connecting device 73 in form of a splicer connects the end sections 19, 25' of the cross yarns 13, 15 so as to form the cross yarn loop 41. As illustrated in figure 11, the connecting device 73 is arranged in cross direction C upstream to the holding devices 75. The connecting device 73 comprises a groove 121 through which the end sections 19, 25' extend when they are hold by the holding device is 75. The groove is Y-shaped. When both end sections 19, 25' are hold by the holding devices 75, the splicer connects the end sections 19, 25' with each other by exposing the end sections 19, 25' with compressed air so as to connect the end sections 19, 25' with each other by splicing. The holding devices 75 and the connecting device 73 are mounted to the support structure 67 of the positioning device 63 by a support stand 123, in particular by a common support stand 123. The holding device 75 and the connecting device 73 are positioned in that the groove 121 of the splicer 73 and the space between the clamps 119 of the holding device are aligned with each other in cross direction C and with the inserting path of the rapier 95.

[0120] The features disclosed in the above description, the figures and the claims may be significant for the realisation of the invention in its different embodiments individually as in any combination.

Reference signs:

[0121]

1	first group of axial yarns
3	second group of axial yarns
5	shedding device
9	space between the axial yarns in cross direction C
11	dashed line
13	first cross yarn
15	second cross yarn
17	cross yarn supply
19	open end section of the first cross yarn
21	closed end section of the first cross yarn
23	closed end section of the second cross yarn
25	closed end section of the second cross yarn
25'	open end section of the second cross yarn
27	end of the first cross yarn
29	closed end section of a continuous cross yarn of the cross yarn supply 17
31	end of the second cross yarn
33	first over portion of the first cross yarn
35	first under portion of the first cross yarn
37	second over portion of the second cross yarn
39	second under portion of the second cross yarn
41	cross yarn loop
43	yarn rope
45	insertion gap inlet
47	insertion gap outlet
51	station for forming a yarn rope
53	reed like structure
55	dents of the reed like structure
57	bars of the reed like structure
59	support structure for the shedding device
61	insertion device
63	positioning device
65	stands of the positioning device
67	support structure of the positioning device
69	linear guidance of the support structure 67
71	linear drives of the positioning device
73	connecting device
75	holding device
77	handling device
79	cross yarn spool
81	support structure of the cross yarn supply
83	stand of the cross yarn supply
85	spool cage
87	handle of the spool cage
89	yarn drive of the cross yarn supply
90	yarn outlet, yarn supply outlet
91	conveying means of the yarn drive
93	clamps of the handling device
95	carrier, rapier
97	rotational axis of the cross yarn spool
99	motor for the yarn supply
101	yarn outlet, cutting device outlet, coat confining the yarn outlet
103	guiding bar
105	guiding bar
107	stands of the guiding bars
109	belt
111	wheel
113	motor of the insertion device 65
115	cutting device/air cutter
117	motor of the handling device 77
119	clamps of the holding devices 75
121	groove of the splicer
123	support stand of the splicer and the holding devices
125	cross yarn supply coat
127	curved recess
129	catch frame
131	recesses of the belt 109
133	guiding wings

135 pivot axis of the handling device

A axial direction
C cross direction
S spacing direction

Claims

1. A method for forming a yarn rope (43), said yarn rope (43) comprising a bundle of axial yarns extending in an axial direction (A) and at least one cross yarn loop inserted in the bundle of axial yarns and extending in a cross direction (C), the cross direction (C) being orientated transversely, in particular perpendicularly, to the axial direction (A), the method comprising the steps of:

   - receiving a plurality of separate axial yarns;
   - creating a first insertion gap confined between the axial yarns and extending in cross direction (C);
   - inserting a first cross yarn (13) in the first insertion gap for forming first under portions (35) and over portions (33) with respect to said axial yarns;
   - creating a second insertion gap confined between the axial yarns and extending in cross direction (C);
   - inserting a second cross yarn (15) in the second insertion gap for forming second under portions (39) and over portions (37) with respect to said axial yarns; and
   - forming the cross yarn loop by connecting the inserted first and second cross yarn (15) with each other,

   characterized in that

   - at least the step of inserting the first and/or second cross yarn (13) is motor driven in particular according to a process control sequence.

2. The method according to claim 1, wherein the step of inserting the first and/or second cross yarn is realized by motor driving a carrier, in particular a rapier, through the first and/or second insertion gap, and/or wherein at least the step of creating the first and/or second insertion gap is motor driven in particular according to a process control sequence.

3. The method according to claim 1 or 2, further comprising the steps of providing the first cross yarn (13) and the second cross yarn (15), wherein the first cross yarn (13) and the second cross yarn (15) are provided from a single continuous cross yarn, wherein preferably the first cross yarn (13) is inserted into the first insertion gap by conveying one part of the continuous cross yarn through the insertion gap, wherein preferably the second cross yarn (15) is inserted into the second insertion gap by conveying another part of the continuous cross yarn through the second insertion gap.

4. The method according to one of the preceding claims, further comprising the steps of providing the first and the second cross yarn (15) from a cross yarn supply (17), such as by winding the first and the second cross yarn (15) from a cross yarn spool, wherein providing the second cross yarn (15) preferably takes place simultaneously to one or more of the steps between the steps of providing the first cross yarn (13) and inserting the first cross yarn (13) into the first insertion gap.

5. The method according one of the proceeding claims, further comprising the step of handing over the first and/or second cross yarn (13, 15) to an insertion device (61) by connecting an end section (19, 25) of the first and/or second cross yarn (13, 15) to a carrier (95) of the insertion device (61), preferably wherein the handing over step is realized by positioning the end section (19, 25) of the first and/or second cross yarn (13, 15) into a moving path of the carrier (95) and subsequently moving the carrier along the moving path so that it picks up the end section (19, 25) of the first and/or second cross yarn (13, 15).

6. The method according to one of the preceding claims, wherein the step of creating the first insertion gap and/or the second insertion gap comprises spacing a first group of the axial yarns (1) from a second group of the axial yarns (3), wherein preferably the axial yarns (1) of the first group and the axial yarns (3) of the second group are alternated in cross direction (C), and/or wherein the second insertion gap is created such that over portions (33) and under portions (35) formed by the first cross yarn (13) bypass the plurality of axial yarns outside the second insertion gap.

7. The method according to one of the preceding claims, wherein the steps of inserting the first and second cross yarn (15) in the first and the second insertion gap comprise conveying the respective cross yarn from a respective insertion gap inlet (45) to a respective insertion gap outlet (47) in cross direction (C), wherein preferably the insertion gap inlets (45) of the first and second cross yarn are located on the same side of the first and second insertion gap in cross direction (C) and/or wherein preferably the insertion gap outlets (47) of both cross yarns are located on the same side of the first and second insertion gap in cross direction (C).

8. The method according to one of the preceding claims, wherein the step of connecting the first and second inserted cross yarn (13, 15) is conducted by

connecting end sections (19, 25') of the first and second cross yarn (13, 15) in particular by splicing, preferably wherein the first and second cross yarn (13, 15) are provided by one single continuous cross yarn so that each of the first and second cross yarn (13, 15) comprise only one end section (19, 25'), in particular open end section, which has to be connected with the other end section (19, 25') so as to form the cross yarn loop, preferably wherein the end section (25') of the second cross yarn (15) is provided by a step of cutting the cross yarn from a cross yarn supply (17) before inserting the second cross yarn (15) in the insertion gap.

9. The method according to any of the preceding claims, wherein at least the step of creating the first and/or second insertion gap, connecting the inserted first and second cross yarn (15) with each other, providing the first and/or second cross yarn, and/or handing over the first and/or second cross yarn to the insertion device is motor driven, in particular according to a process control sequence.

10. The method according to one of the preceding claims, wherein the insertion of the cross yarn loop is initiated according to a process control sequence, wherein the process control sequence preferably initiates the insertion of the cross yarn loop in predetermined process states, such as in predetermined time intervals and/or predetermined yarn rope lengths being formed.

11. A station for forming a yarn rope (43) in particular according to the method of one of the claims 1 to 10, wherein the yarn rope (43) comprises a bundle of axial yarns extending in an axial direction (A) and at least one cross yarn loop inserted in the bundle of axial yarns and extending in a cross direction (C), the cross direction (C) being orientated transversely, in particular perpendicularly, to the axial direction, the station comprising:

- a shedding device (5) for receiving a plurality of separate axial yarns and for creating an insertion gap confined between axial yarns and extending in cross direction (C);
- an insertion device (61) for inserting a cross yarn in the insertion gap for forming under portions (35, 39) and over portions (33, 37) with respect to the axial yarns; and optionally
- a connecting device (73) for forming the cross yarn loop by connecting the inserted cross yarns, wherein

the insertion device (61) is driven by a motor.

12. The station according to claim 10, wherein the insertion device comprises a carrier, in particular a rapier, being movable in cross direction in particular along the insertion gap, and/or wherein the shedding device (5) and the insertion device (61) are driven by separate motors.

13. The station according to claim 11 or 12, further comprising a cross yarn supply (17) for providing the cross yarn, wherein the cross yarn supply (17) is preferably coupled with a motor of the station for driving the cross yarn supply (17), wherein preferably the motor is coupled to a control unit of the station for triggering the motor according to a process control sequence, and/or wherein preferably the control unit is configured to trigger the cross yarn supply (17) to provide the insertion device (61) with a continuous cross yarn of at least two times or at least three times the length of the extension of the plurality of axial yarns in the shedding device (5) in cross direction (C).

14. The station according to one of the claims 11 to 13, further comprising a handling device (77) for handing over the cross yarn to the insertion device (61), in particular for handing over the cross yarn from a cross yarn supply (17) to the yarn insertion device (61), in particular wherein the handling device is movable, in particular pivotable, in that it can position the cross yarn on a moving path of the insertion device along which the insertion device is movable in that it can pick up the cross yarn, and/or wherein the handling device (77) is preferably coupled with a motor of the station for driving the handling device (77), in particular wherein the motor is coupled to a control unit of the station for triggering the motor according to a process control sequence.

15. The station according to claim 14, wherein the handling device (77) comprises two clamps (93) for grabbing the cross yarn (11, 13) in a clamping position, wherein the handling device comprises two guiding wings (133) confining a guiding path between a yarn supply (17) and the clamps (93) in the clamping position, in particular wherein the guiding wings (133) confine a v-shaped guiding path in particular expanding towards the yarn supply (17) and/or are shaped as male part to a recess in a coat confining a yarn outlet (101), in particular in that, in the clamping position, the guiding wings (133) and the coat are in contact with each other and confine a particularly half cylindrical guiding channel between the yarn supply (17) and the clamps (93).

16. The station according to one of the claims 11 to 15, further comprising a positioning device (63) for aligning the insertion device (61) with an insertion gap formed by the shedding device (5), wherein the positioning device (63) is preferably coupled with a motor of the station for driving the positioning device

(63), wherein preferably the motor is coupled to a control unit of the station for triggering the motor according to a process control sequence, wherein preferably the inserting device is coupled to a connecting device (73), a handling device (77), a cutting device (115), a holding device (75) and/or a cross yarn supply (17) in such a way that aligning the insertion device (61) with the insertion gap causes a displacement of the insertion device (61) and of the connecting device (73), handling device (77), cutting device (115), holding device (75) and/or cross yarn supply (17) to the same extend and/or in the same direction.

17. The station according to one of the claims 11 to 16, further comprising a holding device (75) for holding at least one, preferably at least two, inserted cross yarns in a connecting device (73), wherein the holding device (75) is preferably coupled with a motor of the station for driving the holding device (75), wherein preferably the motor is coupled to a control unit of the station for triggering the motor according to a process control sequence.

18. The station according to one of the claims 11 to 17, further comprising a cutting device (115) for cutting off the cross yarn from the yarn supply, wherein the cutting device (115) is preferably coupled with a motor, in particular a pneumatic drive, of the station for driving the cutting device (115), wherein preferably the motor is coupled to a control unit of the station for triggering the motor according to a process control sequence, and/or wherein the station comprises a connecting device (73) realized as a splicer, in particular a pneumatically driven splicer.

19. The station according to one of the claims 11 to 18, further comprising a tracking device, such as a sensor or a counter, for tracking predetermined process states, such as predetermined time intervals and/or predetermined yarn rope lengths being formed, preferably wherein a control unit is configured to initiate the insertion of the cross yarn loop upon receiving the predetermined process states from the tracking device, and/or further comprising a bundling station for bundling the separate axial yarns including the inserted cross yarn loop to a rope (43) and/or a rope warping machine for winding the rope on a bobbin.

20. A yarn rope (43), in particular formed by a method according to one of the claims 1 to 10 or by a station according to one of the claims 11 to 19, comprising a bundle of axial yarns extending in an axial direction (A) and at least one cross yarn loop inserted in the bundle of axial yarns and extending in a cross direction (C), the cross direction being orientated transversely, in particular perpendicularly, to the axial direction (A), wherein the cross yarn loop comprises two cross yarn end sections (19, 25) being connected with each other by splicing, in particular wherein wherein the cross yarn loop is formed from one single yarn, in particular in that the cross yarn loop comprises only one connecting section in which the two cross yarn end sections are connected with each other, and/or in particular wherein the cross yarn loop comprises thermoplastic and/or thermoset, in particular polyester, material.

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Fig. 1

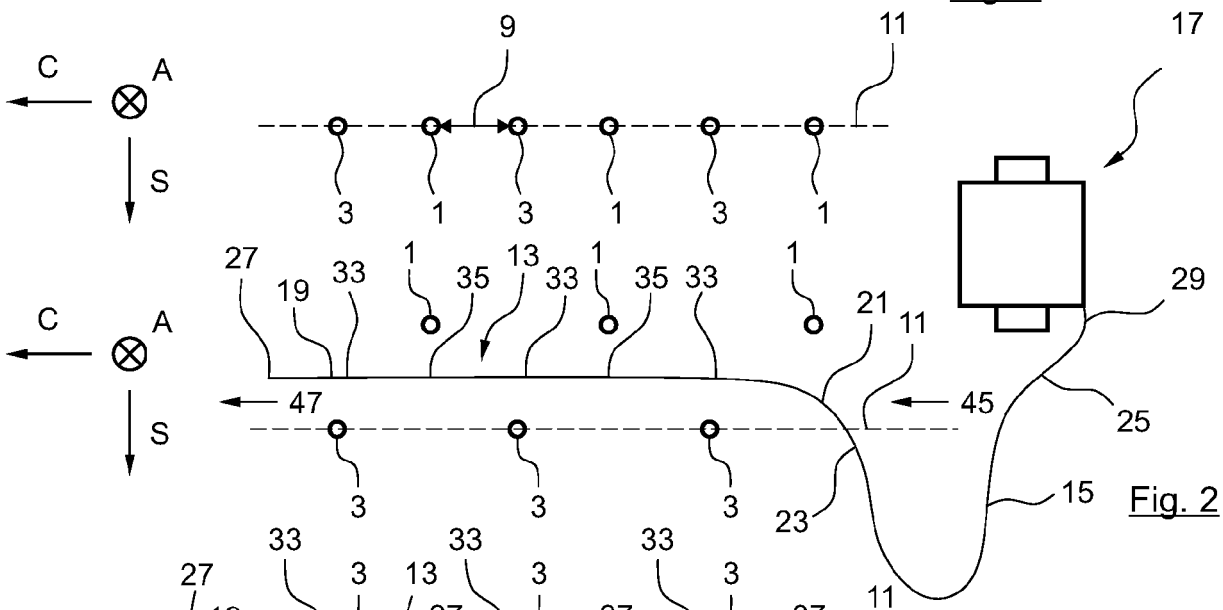

Fig. 2

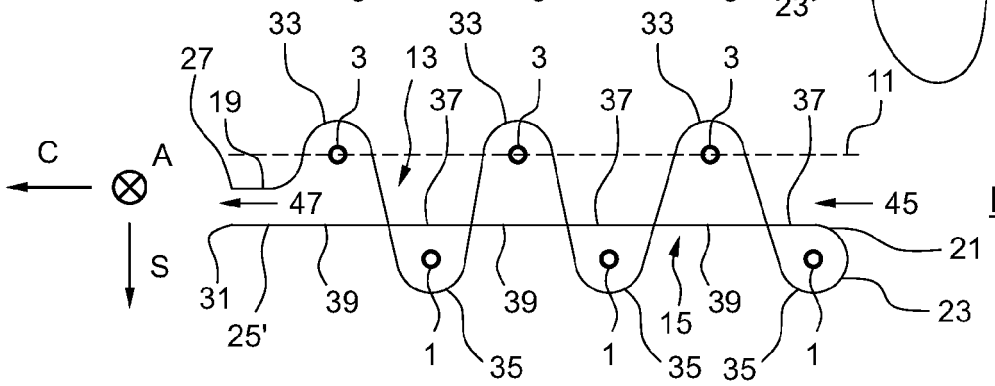

Fig. 3

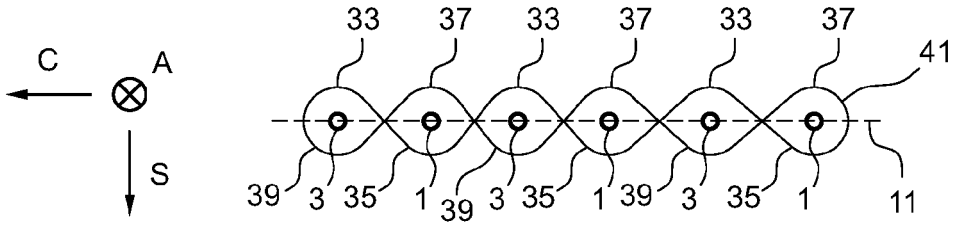

Fig. 4

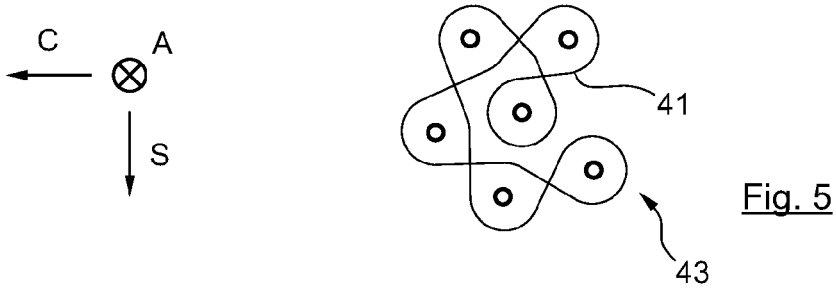

Fig. 5

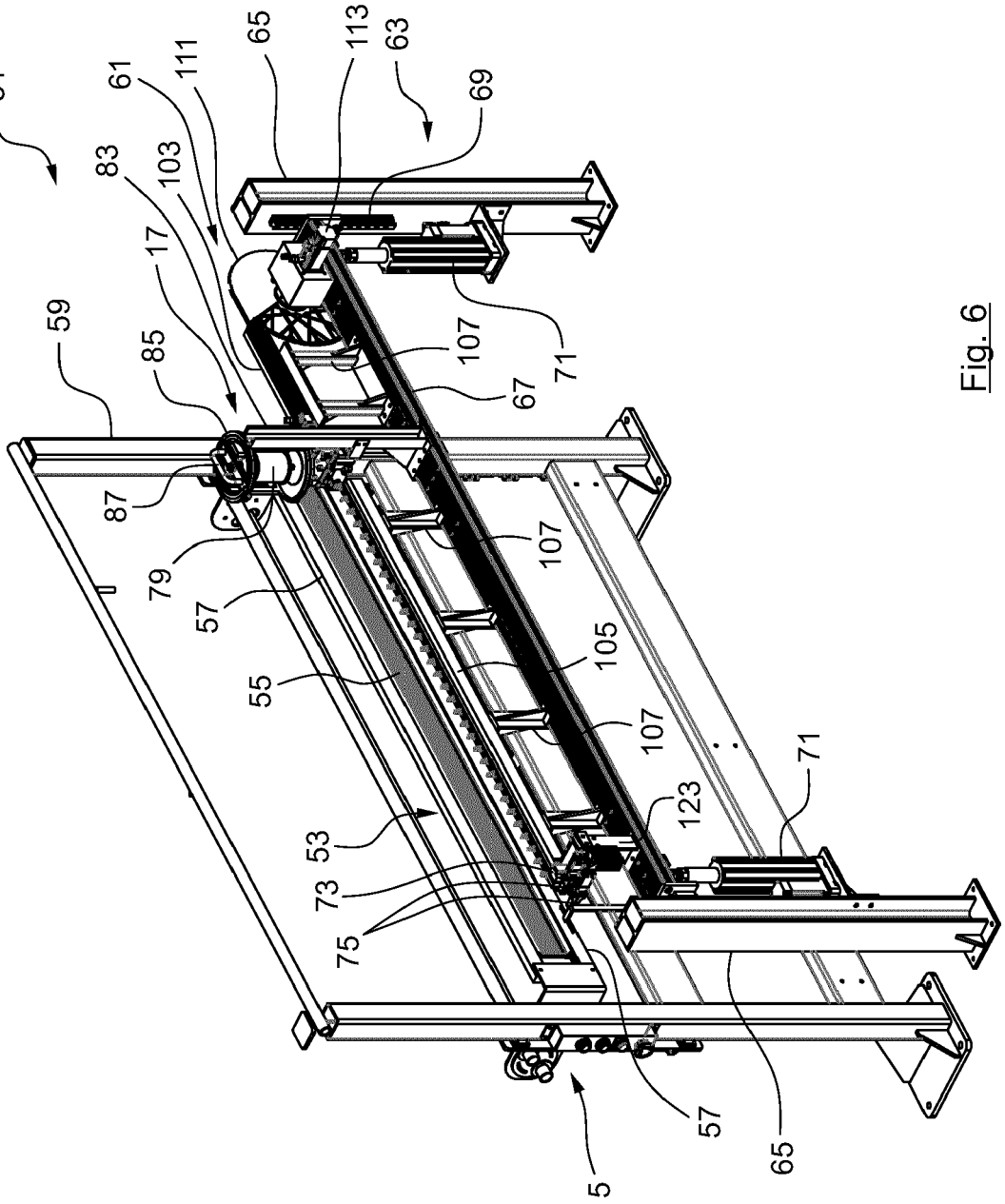
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Fig. 6

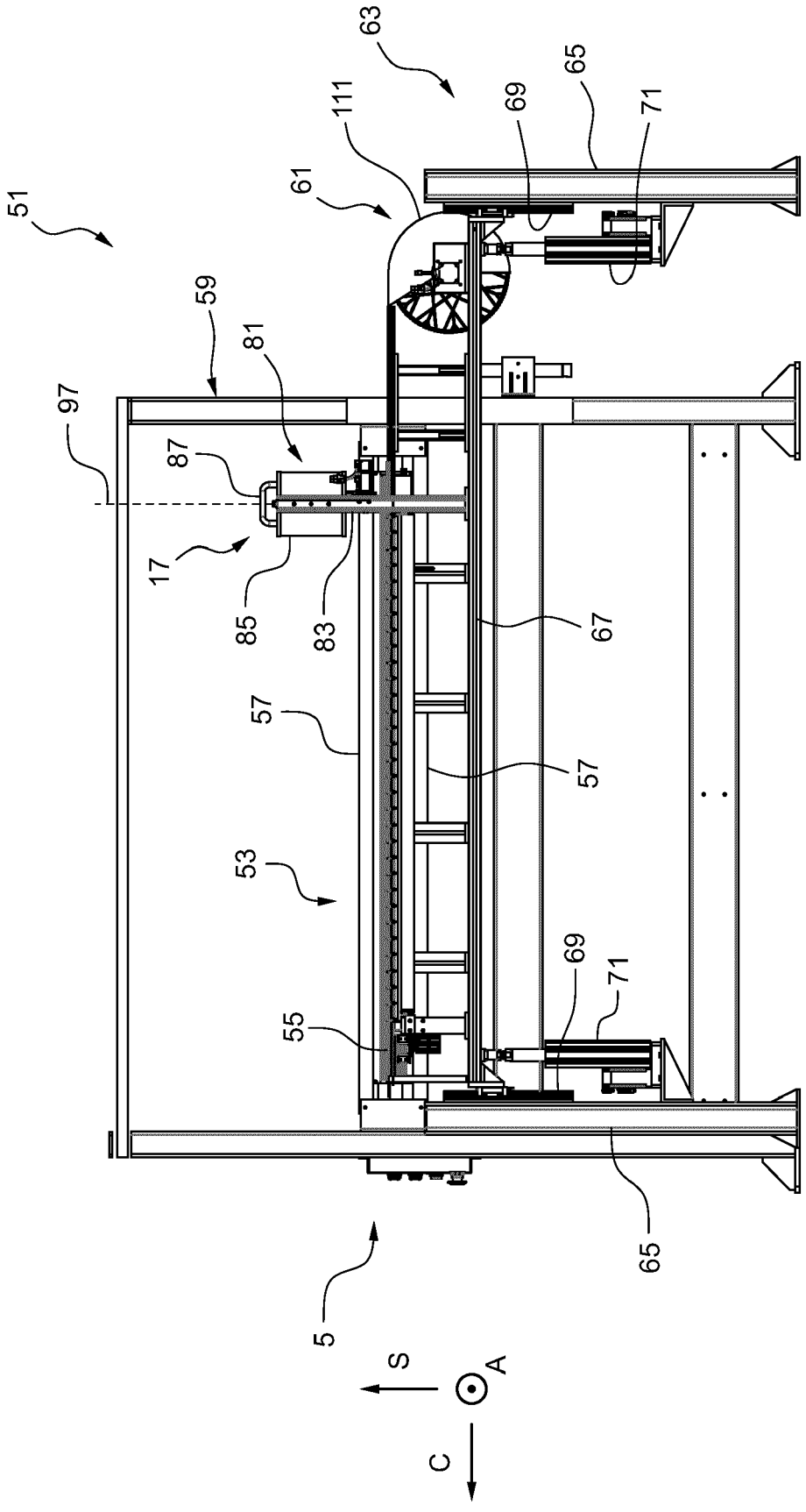

Fig. 7

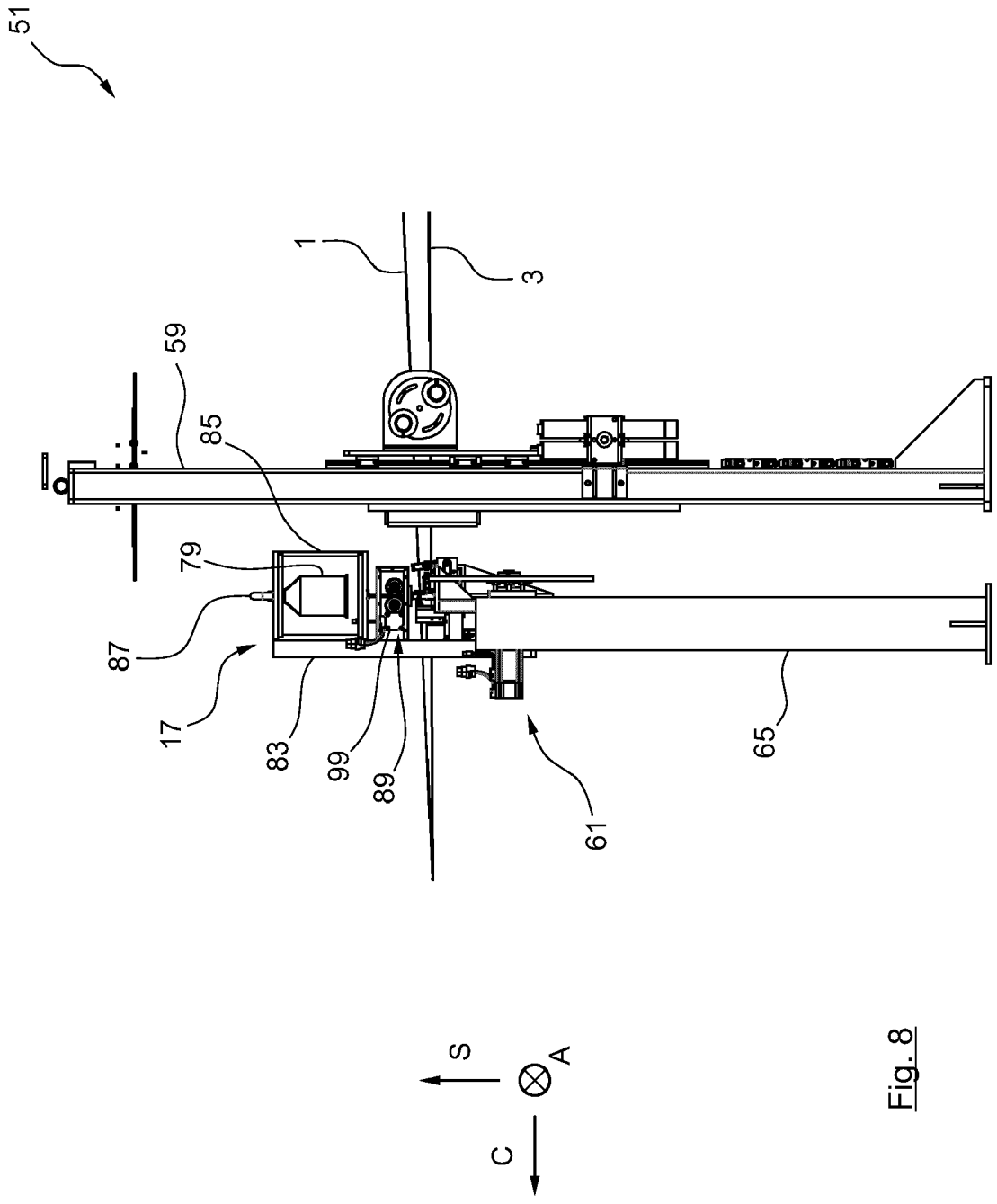

Fig. 8

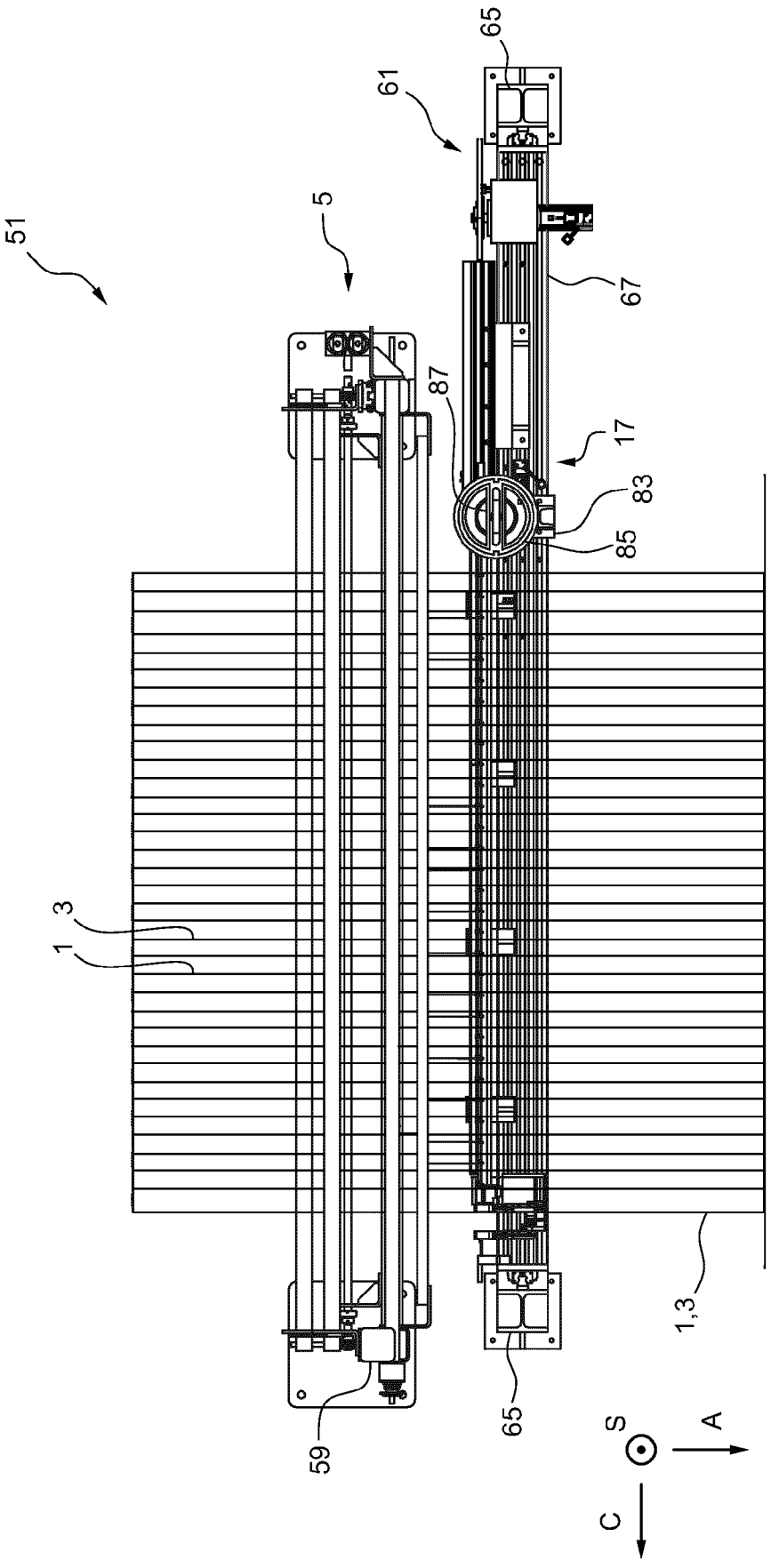

Fig. 9

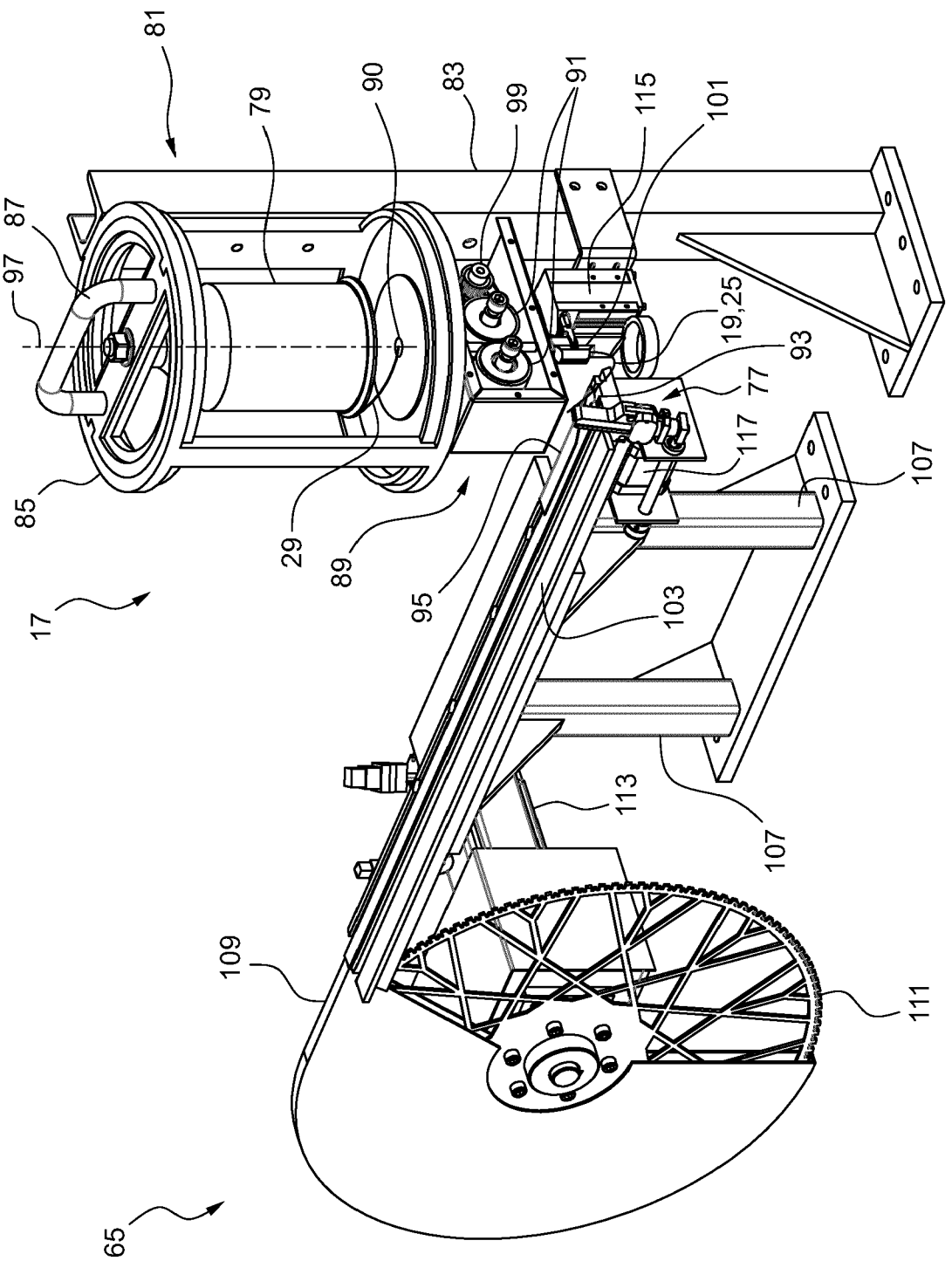
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Fig. 10

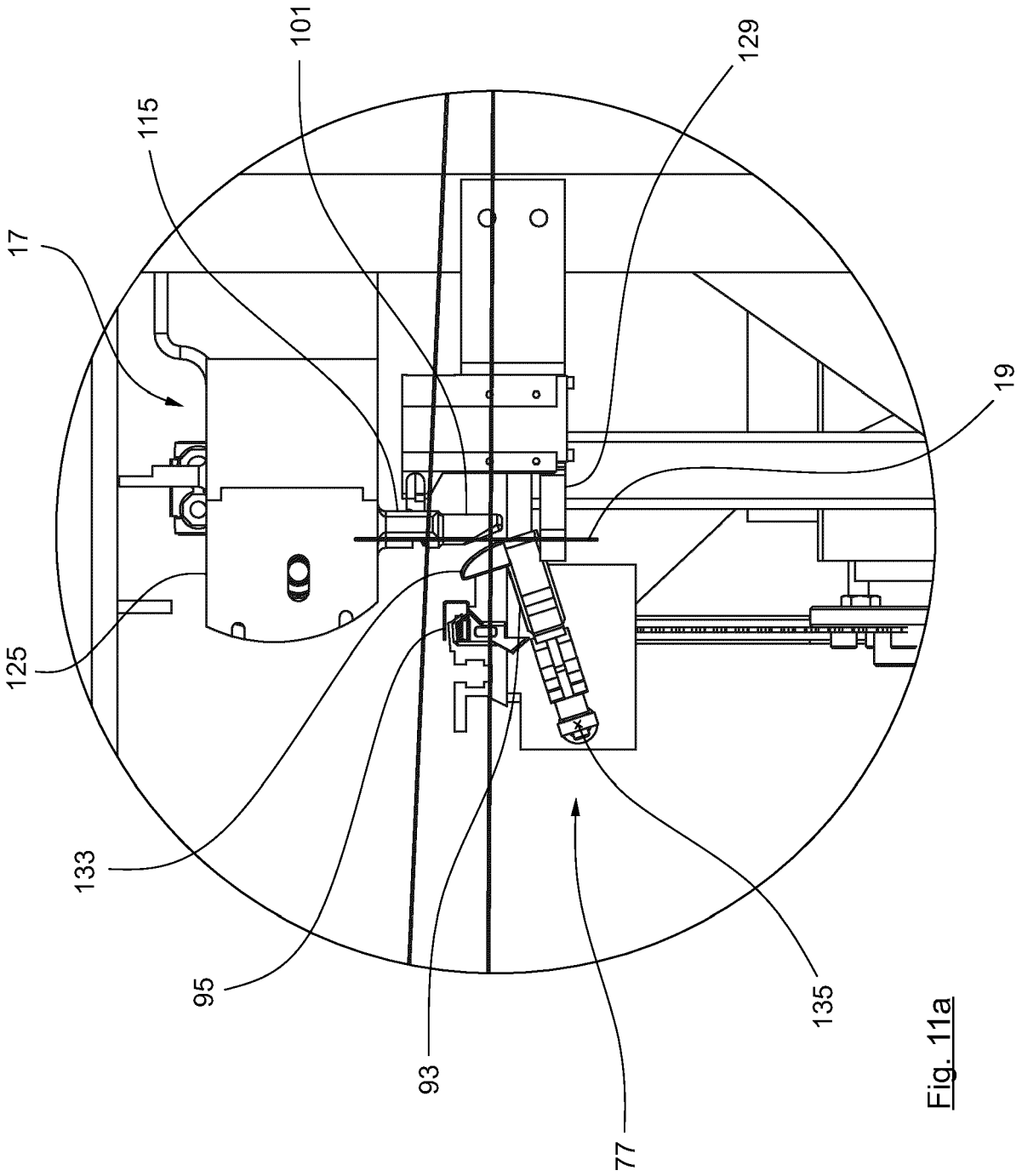

Fig. 11a

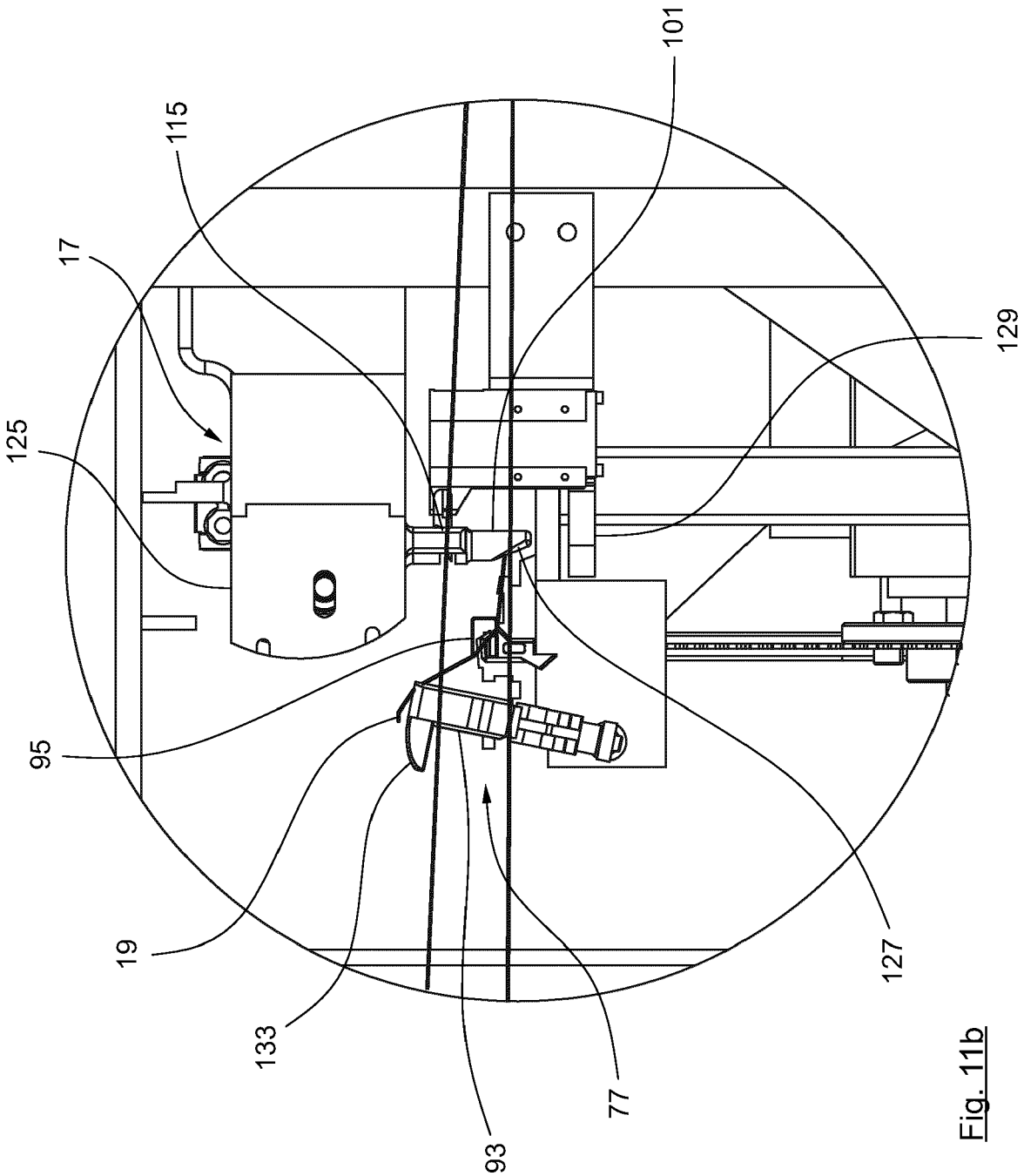

Fig. 11b

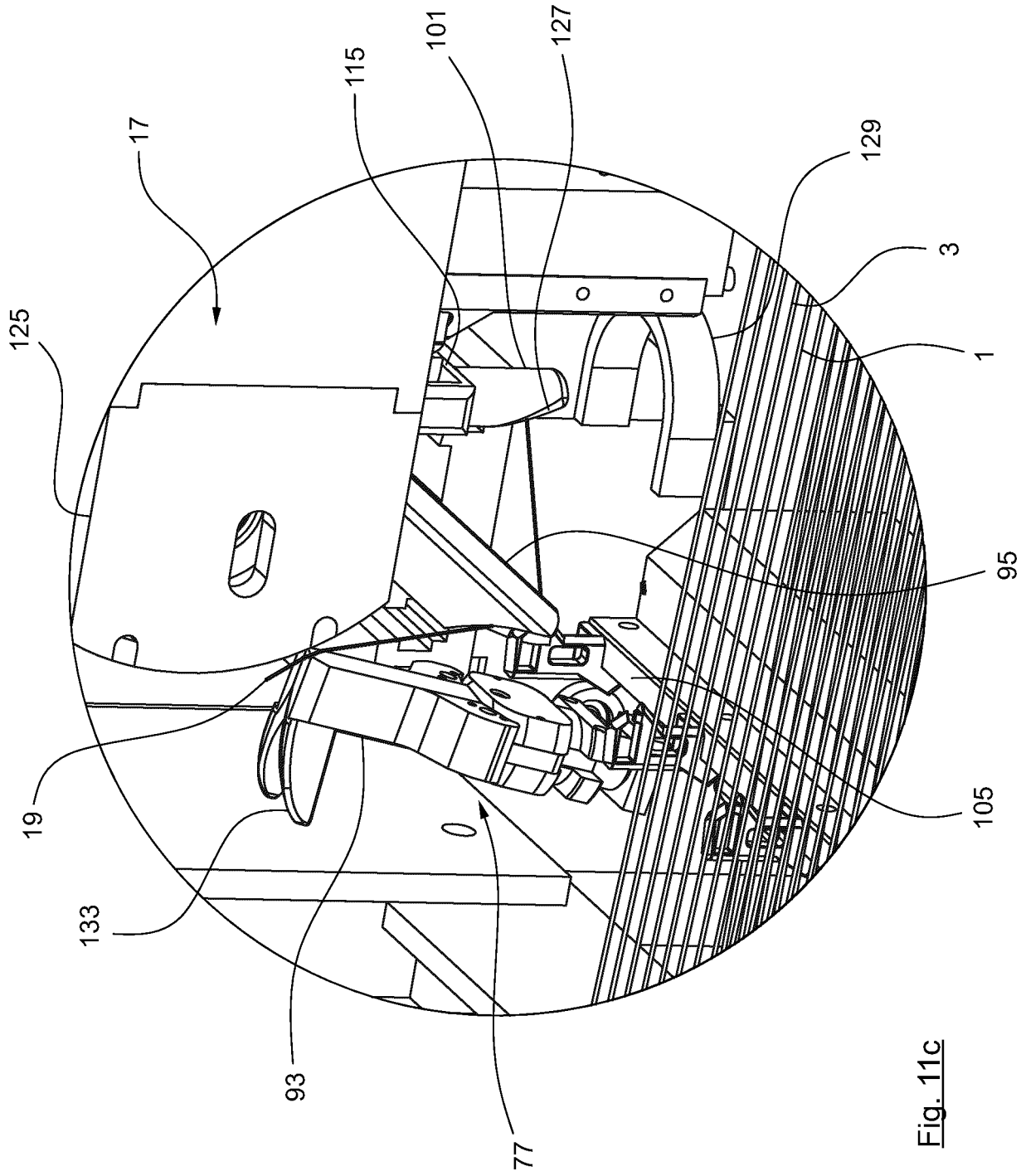

Fig. 11c

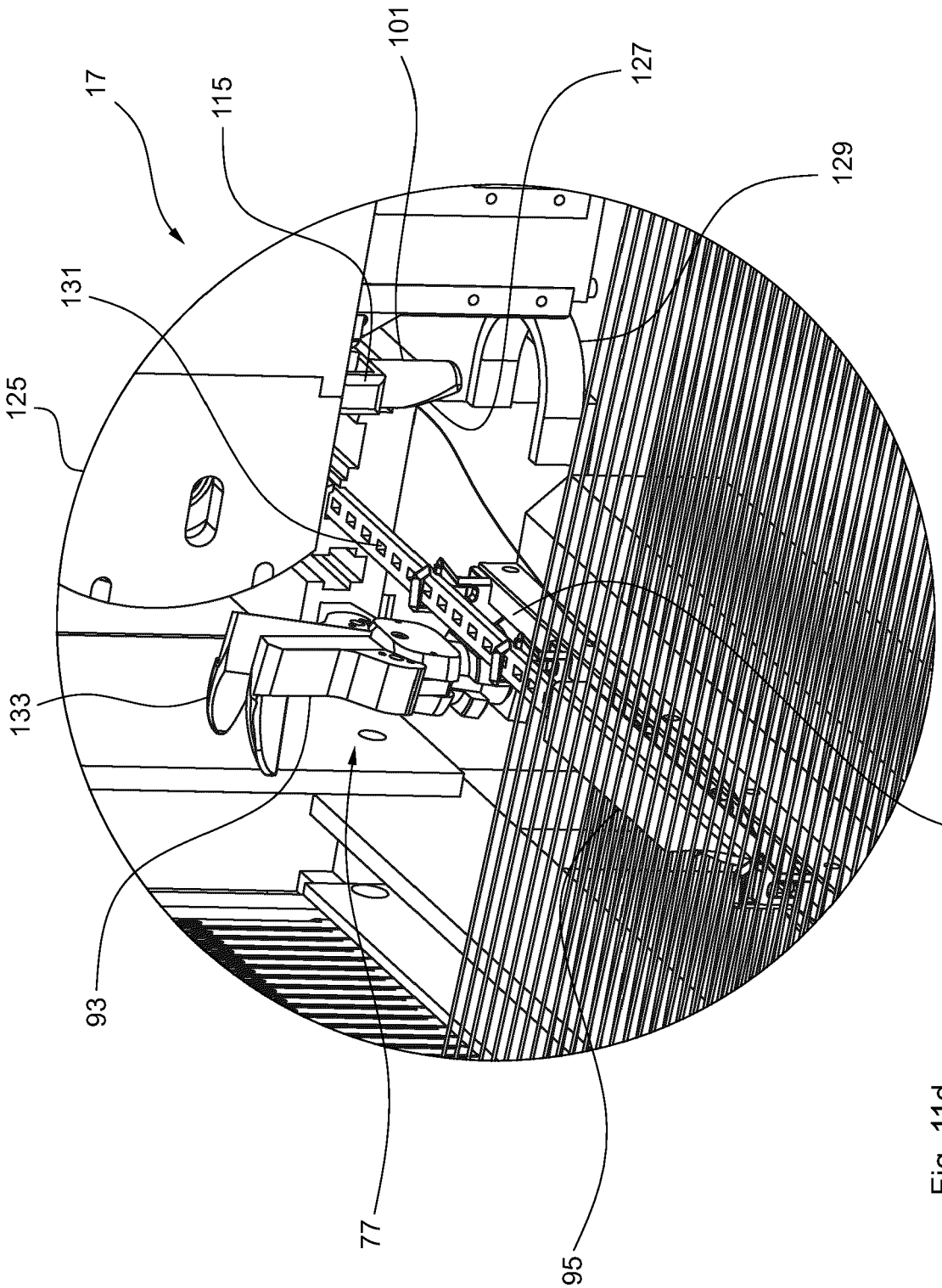

Fig. 11d

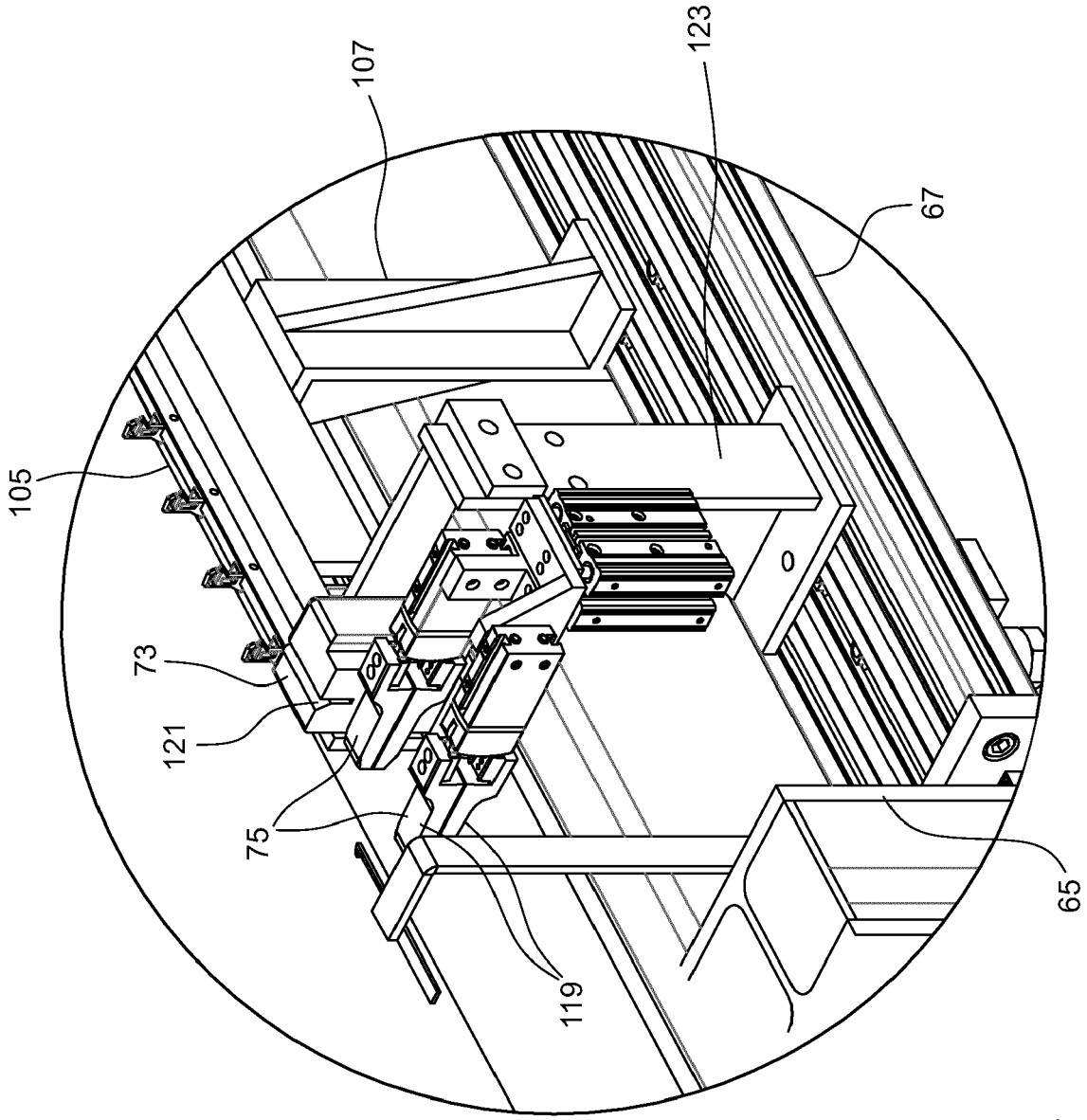

Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 21 16 8379

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D02H
D06B
D03J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 September 2021	Louter, Petrus

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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