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(54) HALF-AUTOMATIC CABLE TWISTING APPARATUS AND TRANSFER METHOD

(57) A half-automatic cable twisting apparatus (10) and a transfer method of a plurality of cable bundles processed in a half-automatic cable twisting apparatus (10) are provided.

The half-automatic cable twisting apparatus (10) comprises a processing unit (100) including a gripper rotation device (110) and a gripper slide (120), the gripper rotation device (110) having a plurality of rotationally supported cable grippers (111, 112, 113, 114) arranged side-by-side, and the gripper slide (120) having a plurality of non-rotational cable grippers (121, 122, 123, 124) arranged side-by-side each corresponding to a respective counterpart out of the plurality of rotationally supported cable grippers (111, 112, 113, 114), wherein the gripper slide (120) is movable along a gripped cable elongation axis (A) to a processing start position (P); and a handling unit (200) including a handling unit slide (220), the handling unit slide (220) having a plurality of handling unit cable grippers (221, 222, 223, 224) arranged side-by-side, wherein the handling unit slide (220) is movable along an axis that is substantially parallel to the gripped cable elongation axis (A).

Each of the handling unit cable grippers (221, 222, 223, 224) is configured to be manually equipped with a first end (311, 312, 313, 314) of a bundle of cables (301, 302, 303, 304) when the handling unit slide (220) is at a handling position (H) in manual reach of the gripper rotation device (110).

The handling unit (200) is configured to transfer the first end (311, 312, 313, 314) of the bundles of cables from the handle unit cable grippers (221, 222, 223, 224) to the non-rotational cable grippers (121, 122, 123, 124) of the processing unit (100) when the gripper slide (120) of the processing unit (100) is at the processing start position (P).

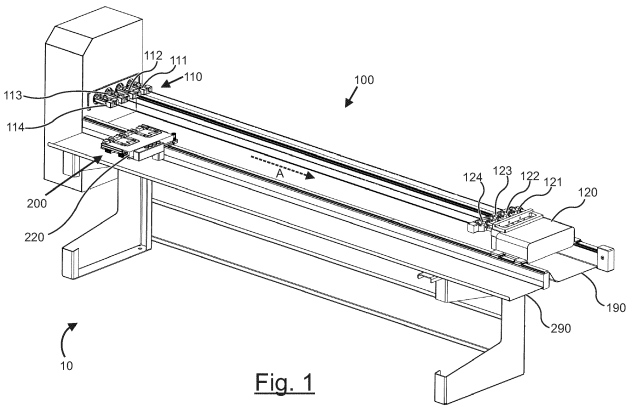

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a half-automatic cable twisting apparatus and a transfer method of a plurality of cable bundles processed in such a half-automatic cable twisting apparatus.

BACKGROUND ART

[0002] In a half-automatic cable twisting apparatus, a cable bundle such as a pair of cables is manually inserted into a twisting device of the apparatus by an operating person. The cable bundle usually comprises two single cables that are stripped from the insulation on their leading end. The leading end may also comprise a crimp contact and/or a grommet on the leading end. The leading end is placed into a part of the twisting device which performs the actual twisting process. Another end, i.e. the rear end, of the respective cable bundle is typically held rotationally stationary, e.g. by means of a suitable cable gripper. Thus, in the twisting operation, the cable bundle typically extends along an axis of the gripped cables, or cable elongation axis. An extended cable bundle forms a cable elongation path.

[0003] When the cable bundle is extended to its full length prior to being twisted, the operating person is responsible for inserting the leading end of the cable bundle into the twisting device as well as for inserting the rear end into the non-rotational cable gripper.

[0004] During the twisting process, since one single cable being turned around the other, i.e. an intertwining process is performed, the cable bundle length is reduced. This length reduction is compensated for by the twisting device. An example of a length reduction compensation comprises moving one of the leading end or the rear end towards the other one in the direction of the cable elongation axis. This length compensation movement is typically performed by the grippers acting against a retractive force of a spring or a pneumatic cylinder. A conventional twisting apparatus is disclosed, for example, in DE 20 2009 004 914 A1.

[0005] In order to be able to process cable bundles having different lengths, the distance between the non-twisting or non-rotating cable grippers on the one end and the twisting device is adjustable. WO 2013 104 187 A1 discloses a twisting device having grippers disposed on a slide that can be moved by means of a motor. This twisting apparatus has two parallel cable elongation paths, i.e. two cable bundles can be processed simultaneously.

[0006] If the cable bundles to be processed exceed a certain length, the operating person that operates or handles the half-automatic cable processing device has to move physically between positions, namely a position at which the leading end of the cable bundle is inserted into the twisting device, and a position at which the rear end is inserted into the non-rotational cable gripper. Also in the approach of processing two cable bundles simultaneously, as described in WO 2013 104 187 A1 discussed above, the operating person has to move. Furthermore, disposing the grippers on the slide that is movable by a motor may help in reducing the movement of the operating person when the configuration is such that the slide moves to the operating person for the inserting operation; however, no twisting operation is possible during the time that the slide is moving.

[0007] Thus, there is a desire for improving the handling and/or the output of a half-automatic cable processing apparatus.

DESCRIPTION OF THE INVENTION

[0008] According to an aspect, a half-automatic cable twisting apparatus is provided. The apparatus comprises a processing unit and a handling unit. The processing unit includes a gripper rotation device and a gripper slide. The gripper rotation device has a plurality of rotationally supported cable grippers that are arranged side-by-side. The gripper slide has a plurality of non-rotational cable grippers that are arranged side-by-side. Each non-rotational cable grippers corresponds to a respective one (a counterpart) out of the plurality of rotationally supported cable grippers. The gripper slide is movable along a gripped cable elongation axis to a processing start position. The handling unit includes a handling unit slide. The handling unit slide has a plurality of handling unit cable grippers. The handling unit cable grippers are arranged side-by-side. The handling unit slide is movable along an axis that is substantially parallel to the gripped cable elongation axis. Each of the handling unit cable grippers is configured such that it can be manually equipped with a first end of a bundle of cables when the handling unit slide is located at a handling position. The handling position is a position within manual reach of the gripper rotation device. The handling unit is configured to transfer the first end of the bundles of cables from the handle unit cable grippers to the non-rotational cable grippers of the processing unit when the gripper slide of the processing unit is at the processing start position.

[0009] According to an aspect, a transfer method of a plurality of cable bundles processed in a half-automatic cable twisting apparatus is provided, the cable twisting apparatus comprising the processing unit and the handling unit as described herein. The transfer method comprises, in the stated order, moving the handling unit slide to a handling position within manual reach of the gripper rotation device; manually equipping each of the handling unit cable grippers with a first end of a bundle of cables; moving the handling unit slide to a position corresponding to the processing start position; and transferring the first end of the bundles of cables from the handling unit cable grippers to the non-rotational cable grippers.

[0010] In the aspects, the cable twisting apparatus is configured to twist a plurality of pre-assembled cable

bundles, each cable bundle comprising a plurality of single cables, typically - without limitation - two single cables.

[0011] Manual reach, as used herein, refers to a location at which two (or more) components can be reached, or handled, by an operating person that operates the half-automatic cable twisting apparatus without requiring the operating person to actively move his or her body between locations. Actively moving includes, for example, walking between the locations. In other words: Two (or more) elements are within manual reach when the operating person need not walk from one element to the other element or use other means of personal transportation such as a conveyor or the like. Definition herein is such that this applies for an average operating person - however, it can be assumed that when the cable length exceeds several meters, the gripper rotation device and the gripper slide at the processing start position are out of manual reach even for an extraordinarily huge operating person.

[0012] For example, the handling position of the handling unit slide being in manual reach of the gripper rotation device, as used herein, means that the operating person can operate, or handle, the rotationally supported cable grippers and the handling unit cable grippers without requiring the operating person to walk in between locations.

[0013] Since the handling unit slide is movable independently from the processing unit, and due to the automated transferring of the first end from the handling unit cable grippers to the non-rotational cable grippers, the operating person need not move between positions when equipping the handling unit cable grippers with the first end of cables. At the same time, equipping the handling unit cable grippers with the first end of cables can take place when the twisting operation of another cable bundle still takes place, thereby raising the output of the apparatus.

[0014] Further aspects, features and advantages are apparent from the dependent claims and embodiments.

[0015] In embodiments, each of the rotationally supported cable grippers of the processing unit is configured to be manually equipped with a second end of a bundle of cables when the handling unit slide is remote from the handling position.

[0016] The handling unit slide being remote from the handling position means that the handling unit slide is not in manual reach of the gripper rotation device, e.g. at the processing start position. For example, the handling unit slide is at the processing start position for transfer of cable bundles to the processing unit.

[0017] In further embodiments, the handling unit further comprises a handling vat. The handling vat is arranged below the handling unit slide, i.e. in a direction in which processed cable bundles or the like will fall when fed through the apparatus, for example. The handling vat is configured such that it supports the bundles of cables.

[0018] In yet further embodiments, the handling unit further comprises a plurality of light barriers. Each of the light barriers is configured to issue a signal for operating a corresponding one of the handling unit cable grippers when the first end has been manually inserted thereto. For example, one or more handling unit cable grippers, typically each of the handling unit cable grippers, is assigned a light barrier, i.e. a corresponding light barrier. When the first end has been manually inserted into a respective handling unit cable gripper, the light barrier issues a signal, whereupon e.g. a controller controls the handling unit cable gripper to be operated, e.g. closed.

[0019] Provision of a light barrier may help in easing the operation or handling of the cable grippers in the handling unit, for example for raising the output yet further.

[0020] In yet further embodiments, the handling unit further comprises a plurality of push buttons. Each push button is configured to operate a corresponding one of the handling unit cable grippers. For example, one or more handling unit cable grippers, typically each of the handling unit cable grippers, is assigned a push button, i.e. a corresponding push button. When the push button is pressed, typically manually pressed, the push button issues a signal, whereupon e.g. a controller controls the handling unit cable gripper to be operated, e.g. opened.

[0021] Provision of a push button may help in easing the operation or handling of the cable grippers in the handling unit. In particular in connection with a light barrier, the push button may be used to open a cable gripper accidentally closed by the light barrier.

[0022] In yet further embodiments, one or more of the handling unit cable grippers comprises a cable limit stop. Typically, each of the handling unit cable grippers comprises a cable limit stop. A cable limit stop may help the operating person in correctly positioning the cable end in the unit.

[0023] In yet further embodiments, the gripper slide is mounted on a linear guide. At least the processing start position is adaptable to different lengths of cable bundles. In other words: The linear guide can be used to adapt the processing start position such that different lengths of cable bundles can be processed by the apparatus. For example, by programming or by manual adaption, the gripper slide of the processing unit may be moved to an appropriate processing start position dependent on a length of the cables to be processed.

[0024] In yet further embodiments, one or more non-rotational cable grippers, typically each of the non-rotational cable grippers, is/are suspended from the gripper slide via a corresponding resilient member. Thereby, a length compensation is achieved when the cable bundles are reduced in length during the processing operation, i. e. during the twisting. During the twisting, a force due to the length reduction acts in the opposite direction of a retractive force provided by the resilient member.

[0025] In this connection, the resilient member may comprise a guide rod that is mounted to a compensation pneumatic cylinder. The compensation pneumatic cylinder provides the retractive force via its pneumatic configuration.

[0026] In yet further embodiments, the processing unit further comprises a lifting pneumatic cylinder. The lifting pneumatic cylinder is configured such that it lifts one or more of the handling unit cable grippers, typically each handling unit cable gripper, to a positioning level of a corresponding non-rotational cable gripper. This operation is typically performed in the transferring process of the first end of the bundles of cables from the handle unit cable grippers to the non-rotational cable grippers of the processing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Embodiments of the disclosure will be described in more detail with reference to the drawings in which:

Fig. 1 shows a perspective view of a half-automatic cable twisting apparatus according to an embodiment;

Fig. 2 shows a perspective view of details of the half-automatic cable twisting apparatus of Fig. 1;

Fig. 3 shows a perspective bottom view of a handling unit of the half-automatic cable twisting apparatus of Fig. 1;

Fig. 4 shows a perspective view of a gripper slide of a processing unit of the half-automatic cable twisting apparatus of Fig. 1;

Fig. 5 shows a perspective view of the half-automatic cable twisting apparatus similar to Fig. 1 for explaining a state in a transfer method according to an embodiment;

Fig. 6 shows a perspective view of the gripper slide in the half-automatic cable twisting apparatus of Fig. 5 for explaining a state in the transfer method according to the embodiment;

Fig. 7 shows a perspective view of the half-automatic cable twisting apparatus of Fig. 5 for explaining a state in the transfer method according to the embodiment;

Fig. 8 shows a perspective view of the gripper slide in the half-automatic cable twisting apparatus of Fig. 5 for explaining a state in the transfer method according to the embodiment;

Fig. 9 shows a perspective view of the gripper slide in the half-automatic cable twisting apparatus of Fig. 5 for explaining a state in the transfer method according to the embodiment;

Fig. 10 shows a perspective view of the half-automatic cable twisting apparatus of Fig. 5 for explaining a state in the transfer method according to the embodiment; and

Fig. 11 shows a perspective view of the half-automatic cable twisting apparatus of Fig. 5 for explaining a state in the transfer method according to the embodiment.

DESCRIPTION OF EMBODIMENTS

[0028] Fig. 1 shows a perspective view of a half-automatic cable twisting apparatus 10 according to an embodiment. The cable twisting apparatus 10 comprises a processing unit 100 and a handling unit 200, both discussed later in more detail.

[0029] The processing unit 100 has a gripper rotation device 110 and a gripper slide 120. The gripper rotation device 110 has a plurality of rotationally supported cable grippers 111, 112, 113, 114. The rotationally supported cable grippers 111, 112, 113, 114 are arranged side-by-side. The gripper slide 120 has a plurality of non-rotational cable grippers 121, 122, 123, 124. The non-rotational cable grippers 121, 122, 123, 124 are arranged side-by-side. Each non-rotational cable gripper 121, 122, 123, 124 has a counterpart in the plurality of rotationally supported cable grippers 111, 112, 113, 114 for conducting a twisting operation of a cable bundle, as discussed below in more detail.

[0030] When a cable bundle is gripped by one of the rotationally supported cable grippers, e.g. rotationally supported cable gripper 111, and its counterpart of the non-rotational cable grippers 121, 122, 123, 124, the cable bundle extends along a gripped cable elongation axis A. The gripper slide is supported such as to be movable substantially along the gripped cable elongation axis A, or along an axis that is substantially parallel to the gripped cable elongation axis A.

[0031] The handling unit 200 has a handling unit slide 220. The handling unit slide 220 has a plurality of handling unit cable grippers 221, 222, 223, 224. The handling unit cable grippers 221, 222, 223, 224 are arranged side-by-side. The handling unit slide 220 is supported such as to be movable along an axis that is substantially parallel to the gripped cable elongation axis A.

[0032] Each of the handling nit cable grippers 221, 222, 223, 224 can be manually equipped, e.g. by an operating person, with a first end 311, 312, 313, 314 of a bundle of cables 301, 302, 303, 304, which is described in more detail below. Equipping may take place when the handling unit slide 220 is at a handling position H, as discussed further below.

[0033] The handling unit 200 is configured to transfer the first end 311, 312, 313, 314 from the handle unit cable grippers 221, 222, 223, 224 to the non-rotational cable grippers 121, 122, 123, 124 of the processing unit when the gripper slide is at a processing start position P, as discussed further below.

[0034] In Fig. 1, a handling vat 290 is arranged below the handling unit slide 220. In addition, a tray vat 190 is arranged below the gripper slide 120. During preparation of the processing, the handling vat 290 supports the elongated cable bundles, whereas the tray vat 190 receives the readily twisted cable bundles after the processing has finished.

[0035] Fig. 2 shows a perspective view of details of the half-automatic cable twisting apparatus 10 of Fig. 1. Each of the rotationally supported cable grippers 111, 112, 113, 114, holds an end of one of a plurality of cable bundles 301, 302, 303, 304. The cable bundles 301, 302, 303, 304 extend along the gripped cable elongation axis A.

[0036] The handling unit 200 in Fig. 2 is shown in a state in which it is not equipped with, or free of, cable bundles. The handling unit comprises the handling unit slide 220 on which the plurality of handling unit cable grippers 221, 222, 223, 224 and a gripper operating panel are mounted. The panel comprises push buttons 241, 242, 243, 244 each configured to operate a corresponding one of the handling unit cable grippers 221, 222, 223, 224, e.g. from a closed gripper state to an open gripper state.

[0037] In the embodiment, as shown in Fig. 2, each handling unit cable gripper 221, 222, 223, 224 comprises a cable limit stop 231, 232, 233, 234. The operating person may insert the first end of a cable bundle into the handling unit cable gripper 221, 222, 223, 224 up to the respective cable limit stop 231, 232, 233, 234 for a constant cable quality, e.g. a constant length of the produced twisted cable bundle, and for a correct positioning of the cable bundles.

[0038] The first ends of the cable bundles 301, 302, 303, 304, e.g. pairs of single cables, can be inserted into the handling unit cable grippers 221, 222, 223, 224 from the upper side in Fig. 2. When the grippers 221, 222, 223, 224 have gripped the first ends and are closed subsequently, the handling unit slide 220 runs on a linear guide rail 269, substantially parallel to the gripped cable elongation axis A. For example, and without limitation, movement of the handling unit slide 220 on the linear guide rail 269 is performed via a belt drive located below the linear guide rail 269.

[0039] Fig. 3 shows a perspective bottom view of the handling unit 200, in a position in which the handling unit 200 is ready to transfer the bundles of cables from the handle unit cable grippers 221, 222, 223, 224. In Fig. 3, guide elements 268-1, 268-2 are disposed such as to be guided via the linear guide rail 269.

[0040] In Fig. 3, each handling unit cable gripper 221, 222, 223, 224 comprises a corresponding light barrier 251, 252, 253, 254 connected to a control unit (not shown). When a cable end of a cable bundle 301, 302, 303, 304 is inserted into any of the handling unit cable grippers 221, 222, 223, 224, the corresponding light barrier 251, 252, 253, 254 is activated. An activation signal is issued to the control unit, whereupon the control unit controls the corresponding cable gripper 221, 222, 223, 224 to close, thereby gripping the cable bundle end. Should a light barrier be erroneously activated, the operating person may push the corresponding push button 241, 242, 243, 244 (see Fig. 2), whereupon a push button signal is issued to the control unit. The control unit, in turn, controls the corresponding cable gripper 221, 222, 223, 224 to open.

[0041] It is noted that the light barriers 251, 252, 253, 254 can also be omitted. In this case, for example, the push buttons 241, 242, 243, 244 can be used to toggle the corresponding cable gripper 221, 222, 223, 224 to close or open in an alternating manner.

[0042] In the embodiment shown in Fig. 3, the cable grippers 221, 222, 223, 224 are commonly mounted on a plate that can be moved, guided on two linear guide rails 261, 262 and driven by a rack 266 and pinion 267 drive, in a direction substantially orthogonal to the gripped cable elongation axis A and substantially in the same plane as the gripped cable elongation axis A, for alignment purposes with the non-rotational cable grippers 121, 122, 123, 124 in a transfer process, as described in detail further below.

[0043] In addition, the plate can be moved in the vertical direction, i.e. substantially orthogonal to the plane spanned by the plate. Two swivel hinges 263, 264 allow for the vertical, or upward, pivoting movement of the plate. Lifting of the plate in the transfer process can be conducted via an actuator of the handling device 200, e. g. a pneumatic actuator, or via an externally provided device. The lifting process is described in more detail further below.

[0044] Fig. 4 shows a perspective view of the gripper slide 120 of the processing unit 100. The gripper slide 120 is supported on linear guide rails 161, 162 and movable along the gripped cable elongation axis A. It is noted that in the present embodiment, the linear guide rail 161 of Fig. 4 is the same as the linear guide rail 269 of Fig. 2, thus guiding both the handling unit slide 220 and, on one side thereof, the gripper slide 120. However, no limitation to a common use of the linear guide rails 161, 269 is intended, and distinct linear guide rails may be provided for the gripper slide 120 on the one hand and the handling unit slide 220 on the other hand.

[0045] A belt drive 166 is configured to drive the gripper slide 120 and to adjust a position of the gripper slide 120 to be at an arbitrary location on the linear guides 161, 162. Adjusting the position is performed to be able to process cable bundles of different lengths within the limits given by the dimensions of the apparatus 10, particularly the limits imposed by the length of the linear guides 161, 162. The cable grippers 121, 122, 123, 124 disposed on the gripper slide 120 are of a non-rotational configuration. In the embodiment shown in Fig. 4, each of the cable grippers 121, 122, 123, 124 comprises a fixed gripper jaw and a pneumatically movable gripper jaw (both not shown distinctively) for selectively opening and closing each cable gripper 121, 122, 123, 124 via a movement

of the corresponding movable gripper jar.

[0046] Length compensation pneumatic cylinders, whereof one length compensation pneumatic cylinder 167 is shown in Fig. 4, are provided for length compensation during the twisting process. Guiding rods 131, 132, 133, 134 each assigned to a corresponding one of the cable grippers 121, 122, 123, 124 are respectively mounted to a piston rod of the corresponding pneumatic cylinder 167. The length compensation pneumatic cylinders 167 allow the length reduction of the cable bundles 301, 302, 303, 304 during the twisting process to be compensated for. That is, the length compensation pneumatic cylinders 167 each act such that they impose a retractive force to the cable grippers 121, 122, 123, 124 while at the same time allowing the cable grippers 121, 122, 123, 124 to move along the respective guiding rods 131, 132, 133, 134. In this way, the cable bundles 301, 302, 303, 304 are kept tensioned along the cable elongation axis A. By using the length compensation pneumatic cylinders 167, the retractive force may be adjusted, e.g. via control or regulating valves.

[0047] A lifting pneumatic cylinder 150 is provided below the non-rotational cable grippers 121, 122, 123, 124. The lifting pneumatic cylinder 150 is arranged and configured such that it can be controlled to lift the handling unit cable grippers 221, 222, 223, 224 when located below the non-rotational cable grippers 121, 122, 123, 124 in a transfer process. A corresponding transfer process will be described in the following.

[0048] Figs. 5-11 each show perspective views of the half-automatic cable twisting apparatus 10 similar to Fig. 1, or details of the of the gripper slide 120 and/or handling unit slide 220, for respectively explaining a state in a transfer method according to an embodiment. The cable twisting apparatus 10 is essentially configured as in the embodiment described with reference to Figs. 1-4 above, and the explanation is not repeated here for simplification.

[0049] In the method, it is assumed that an operating person is at a location within manual reach of the gripper rotation device 110, since a manual operation has to be performed on the gripper rotation device 110 during the twisting process, as elaborated further below. In Fig. 5, the handling unit slide 220 is shown in the range of a handling position H. At the handling position, the handling unit slide 220 is in manual reach of the operating person.

[0050] Manual reach is a location at which the operating person can handle the respective element without requiring the operating person to actively move his or her body. In Fig. 5, the operating person does not have to change locations in order to be able to handle both the (stationary) gripper rotation device 110 and the handling unit slide 220 which is, in the stage shown in Fig. 5, at the handling position H. Note that the handling position may also refer to a certain tolerance range, as shown, in which a manual operation or handling by the operating person is possible.

[0051] The handling position of the handling unit slide 220 being in manual reach of the gripper rotation device 110 means that the operating person can operate, or handle, the rotationally supported cable grippers 111, 112, 113, 114 and the handling unit cable grippers 221, 222, 223, 224 without requiring the operating person to walk in between locations. In other words:

[0052] The operating person may stay at one location when handling, or operating, the apparatus 10 for a plurality of twisting operations, such as more than ten or more than 100 twisting operations.

[0053] Fig. 5 shows the initial position, or initial state. One or more twisting processes may still be performed by the processing unit 100 when the operating person may start equipping the handling unit 200 with another one or more cable bundles. Since in the initial state, the handling unit slide 220 is at the handling position, the operating person can perform an operation thereon, e.g. insert one or more cable bundles 301, 302, 303, 304 into respectively one or more of the handling unit cable grippers 221, 222, 223, 224. Depending on the application or external circumstances, such as the cable length, it is conceivable that only a part of the cable grippers are used. A controller may take care of the number of cable grippers to be used in an actual twisting process. In the following, it is assumed - without any limitation intended - that four cable bundles 301, 302, 303, 304 are handled at the same time.

[0054] Fig. 6 shows a perspective view of the gripper slide 220 in the half-automatic cable twisting apparatus 10 of Fig. 5 for explaining the next state in the transfer method according to the embodiment. Cable ends 311, 312, 313, 314 of the cable bundles 301, 302, 303, 304 are respectively inserted into the cable grippers 221, 222, 223, 224 up to the respective limit stop 231, 232, 233, 234, and the cable grippers 221, 222, 223, 224 are closed. The gripper slide 220 is moved along the linear guide up to a transfer position T, or transfer location.

[0055] In the perspective view of Fig. 7, the gripper slide 220 is shown at the transfer position T. The transfer position is dependent on the position of the gripper slide 120 on the respective linear guide. The gripper slide 120, at this stage, is located at a position that depends on the length of the cable bundles prior to the twisting process.

[0056] By the movement of the gripper slide 220, the cable bundles 301, 302, 303, 304 are drawn in a direction parallel to the gripped cable elongation axis A, and they are supported by the handling vat 290.

[0057] In Fig. 7, the processing unit 100 is still equipped with cable bundles 301, 302, 303, 304 that are twisted. The twisted cable bundles 301, 302, 303, 304 are ejected into the tray vat 190. In this process, the rotationally supported cable grippers 111, 112, 113, 114 are turned such that their respective insert openings face downwards. The gripper slide 120 moves into the direction of the rotationally supported cable grippers 111, 112, 113, 114 such that the tensioning force on the twisted cable bundles 301, 302, 303, 304 is relieved. Then, all cable grippers 111, 112, 113, 114; 121, 122, 123, 124 of the

processing unit 100 are opened, and the twisted cable bundles fall into the tray vat 190.

[0058] Figs. 8 and 9 each show a perspective view of the gripper slide 120 and the handling unit slide 220 in subsequent stages in the transfer process. In Fig. 8, the handling unit slide 220 is located at the transfer position T. The plate of the handling unit slide 220 has been moved, guided on the two linear guide rails 261, 262 and driven by the rack 266 and pinion 267 drive, such that the handling unit cable grippers 221, 222, 223, 224 are each located below a corresponding one of the non-rotational cable grippers 121, 122, 123, 124 of the gripper slide 120.

[0059] In Fig. 9, the lifting pneumatic cylinder 150 is controlled such that it lifts the plate carrying the handling unit cable grippers 221, 222, 223, 224. The handling unit cable grippers 221, 222, 223, 224 are swiveled, or pivoted, via the swivel hinges 263, 264 such that the gripped cable bundles 301, 302, 303, 304 are automatically transferred from the handling unit cable grippers 221, 222, 223, 224 to the non-rotational cable grippers 121, 122, 123, 124 of the gripper slide 120.

[0060] During the automatic transfer process of Figs. 8 and 9, the operating person may already begin to insert the rear ends of the drawn cable bundles 301, 302, 303, 304 into the rotationally supported cable grippers 111, 112, 113, 114. The rotationally supported cable grippers 111, 112, 113, 114 have been turned such that their respective insert openings face upwards.

[0061] Fig. 10 shows a perspective view of a stage when all rear cable ends have been inserted into the rotationally supported cable grippers 111, 112, 113, 114. The gripper slide 120 is at a position E at which the cable bundles 301, 302, 303, 304 hang loosely substantially without any mechanical tension along the gripped cable elongation axis. The gripper slide 120 moves to the processing start position P, as shown in Fig. 11. At this stage, the cable bundles 301, 302, 303, 304 have been tensioned, and the twisting process may start. In the meantime, the handling unit slide 220 has been moved to the handling position H for allowing the operating person to start a subsequent cable bundle end insertion process.

[0062] It is noted that the embodiments, features, aspects and advantages described herein are illustrative, and the person skilled in the art will recognize that various features may be omitted or added without departing from the invention.

Claims

1. A half-automatic cable twisting apparatus (10), comprising:

a processing unit (100) including a gripper rotation device (110) and a gripper slide (120), the gripper rotation device (110) having a plurality of rotationally supported cable grippers (111, 112, 113, 114) arranged side-by-side, and the gripper slide (120) having a plurality of non-rotational cable grippers (121, 122, 123, 124) arranged side-by-side each corresponding to a respective counterpart out of the plurality of rotationally supported cable grippers (111, 112, 113, 114), wherein the gripper slide (120) is movable along a gripped cable elongation axis (A) to a processing start position;

a handling unit (200) including a handling unit slide (220), the handling unit slide (220) having a plurality of handling unit cable grippers (221, 222, 223, 224) arranged side-by-side, wherein the handling unit slide (220) is movable along an axis that is substantially parallel to the gripped cable elongation axis (A),

wherein each of the handling unit cable grippers (221, 222, 223, 224) is configured to be manually equipped with a first end (311, 312, 313, 314) of a bundle of cables (301, 302, 303, 304) when the handling unit slide (220) is at a handling position (H) in manual reach of the gripper rotation device (110),

wherein the handling unit (200) is configured to transfer the first end (311, 312, 313, 314) of the bundles of cables from the handle unit cable grippers (221, 222, 223, 224) to the non-rotational cable grippers (121, 122, 123, 124) of the processing unit (100) when the gripper slide (120) of the processing unit (100) is at the processing start position (P).

2. The half-automatic cable twisting apparatus (10) according to claim 1, wherein each of the rotationally supported cable grippers (111, 112, 113, 114) of the processing unit (100) is configured to be manually equipped with a second end (323, 324) of a bundle of cables (301, 302, 303, 304) when the handling unit slide (220) is remote from the handling position (H) .

3. The half-automatic cable twisting apparatus (10) according to any one of the preceding claims, wherein the handling unit (200) further comprises a handling vat (290) arranged below the handling unit slide (220) for supporting the bundles of cables (301, 302, 303, 304).

4. The half-automatic cable twisting apparatus (10) according to any one of the preceding claims, wherein the handling unit (200) further comprises a plurality of light barriers (251, 252, 253, 254) each configured to issue a signal for operating a corresponding one of the handling unit cable grippers (221, 222, 223, 224) when the first end (311, 312, 313, 314) has been manually inserted thereto.

5. The half-automatic cable twisting apparatus (10) ac-

cording to any one of the preceding claims, wherein the handling unit (200) further comprises a plurality of push buttons (241) each configured to operate a corresponding one of the handling unit cable grippers (221, 222, 223, 224).

6. The half-automatic cable twisting apparatus (10) according to any one of the preceding claims, wherein one or more of the handling unit cable grippers (221, 222, 223, 224), preferably each of the handling unit cable grippers (221, 222, 223, 224), comprises a cable limit stop (231, 232, 233, 234).

7. The half-automatic cable twisting apparatus (10) according to any one of the preceding claims, wherein the gripper slide (120) is mounted on a linear guide, and wherein at least the processing start position (P) is adaptable to different lengths of cable bundles (301, 302, 303, 304).

8. The half-automatic cable twisting apparatus (10) according to any one of the preceding claims, wherein each of the non-rotational cable grippers (121, 122, 123, 124) is suspended from the gripper slide (120) via a resilient member for length compensation during the twisting.

9. The half-automatic cable twisting apparatus (10) according to claim 8, wherein the resilient member comprises a guide rod mounted to a compensation pneumatic cylinder.

10. The half-automatic cable twisting apparatus (10) according to any one of the preceding claims, wherein the processing unit (100) further comprises a lifting pneumatic cylinder (150) configured to lift one or more of the handling unit cable grippers (221, 222, 223, 224) to a positioning level of a corresponding non-rotational cable gripper (121, 122, 123, 124) .

11. A transfer method of a plurality of cable bundles processed in a half-automatic cable twisting apparatus (10), the cable twisting apparatus (10) comprising
a processing unit (100) including a gripper rotation device (110) and a gripper slide (120), the gripper rotation device (110) having a plurality of rotationally supported cable grippers (111, 112, 113, 114) arranged side-by-side, and the gripper slide (120) having a plurality of non-rotational cable grippers (121, 122, 123, 124) arranged side-by-side each corresponding to a respective counterpart out of the plurality of rotationally supported cable grippers (111, 112, 113, 114), wherein the gripper slide (120) is movable along a gripped cable elongation axis (A) between a processing start position (P) and a processing end position (E) ;
a handling unit (200) including a handling unit slide (220), the handling unit slide (220) having a plurality of handling unit cable grippers (221, 222, 223, 224) arranged side-by-side, wherein the handling unit slide (220) is movable along an axis that is substantially parallel to the gripped cable elongation axis (A), wherein the transfer method comprises, in the stated order:

moving the handling unit slide (120) to a handling position (H) in manual reach of the gripper rotation device (110);
manually equipping each of the handling unit cable grippers (221, 222, 223, 224) with a first end (311, 312, 313, 314) of a bundle of cables (301, 302, 303, 304);
moving the handling unit slide (120) to a position corresponding to the processing start position (P);
transferring the first end (311, 312, 313, 314) of the bundles of cables (301, 302, 303, 304) from the handling unit cable grippers (221, 222, 223, 224) to the non-rotational cable grippers (121, 122, 123, 124).

12. The transfer method according to claim 11, further comprising manually equipping the plurality of rotationally supported cable grippers (111, 112, 113, 114) with a second end (323, 324) of a bundle of cables (301, 302, 303, 304) when the handling unit slide (120) is remote from the handling position (H).

13. The transfer method according to claim 10 or 11, further comprising lifting the plurality of handling unit cable grippers (221, 222, 223, 224) up to a positioning level of a corresponding non-rotational cable gripper (121, 122, 123, 124) .

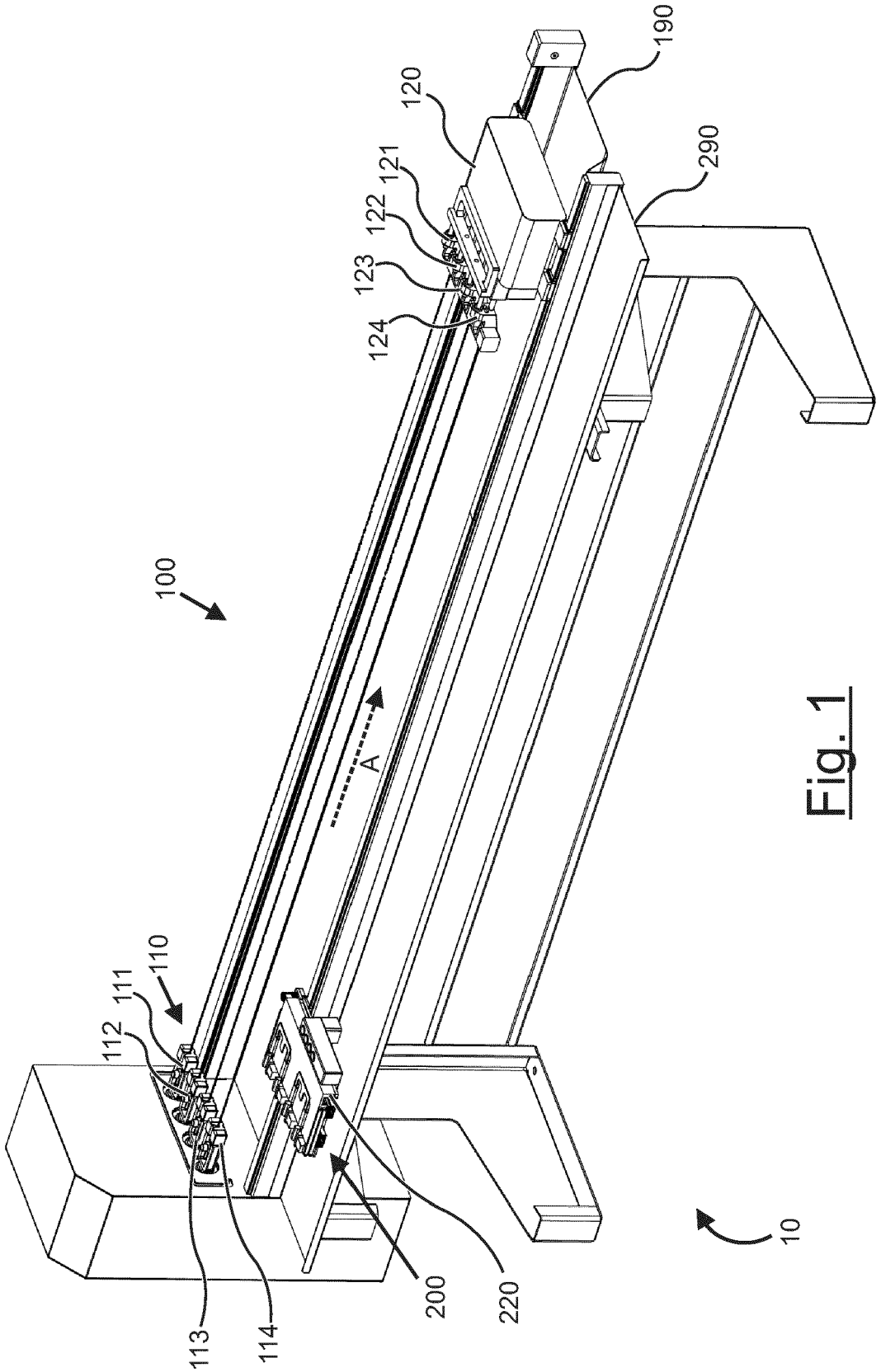
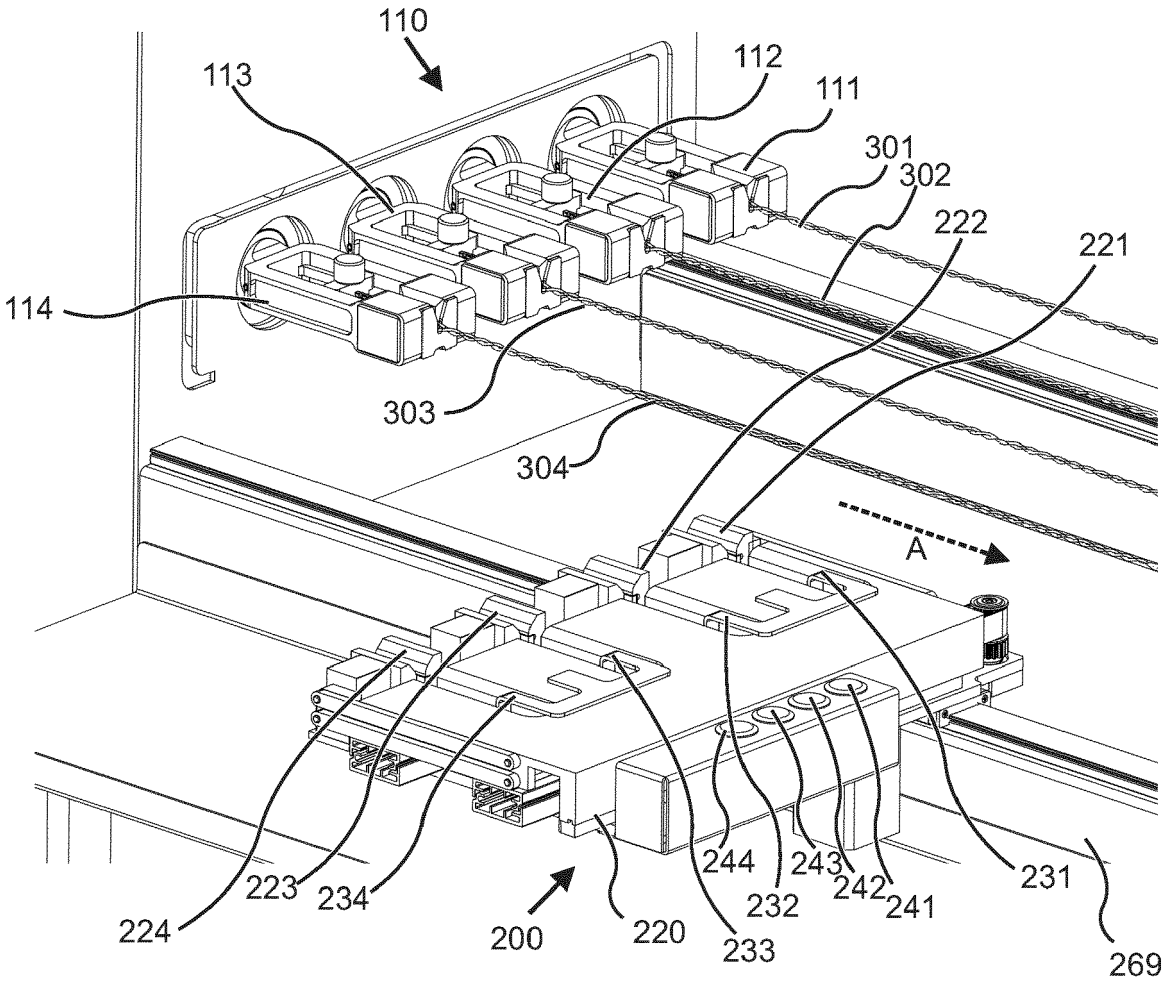


Fig. 1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113
112
111
301
302
222
221
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304
A
224
223
234
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220
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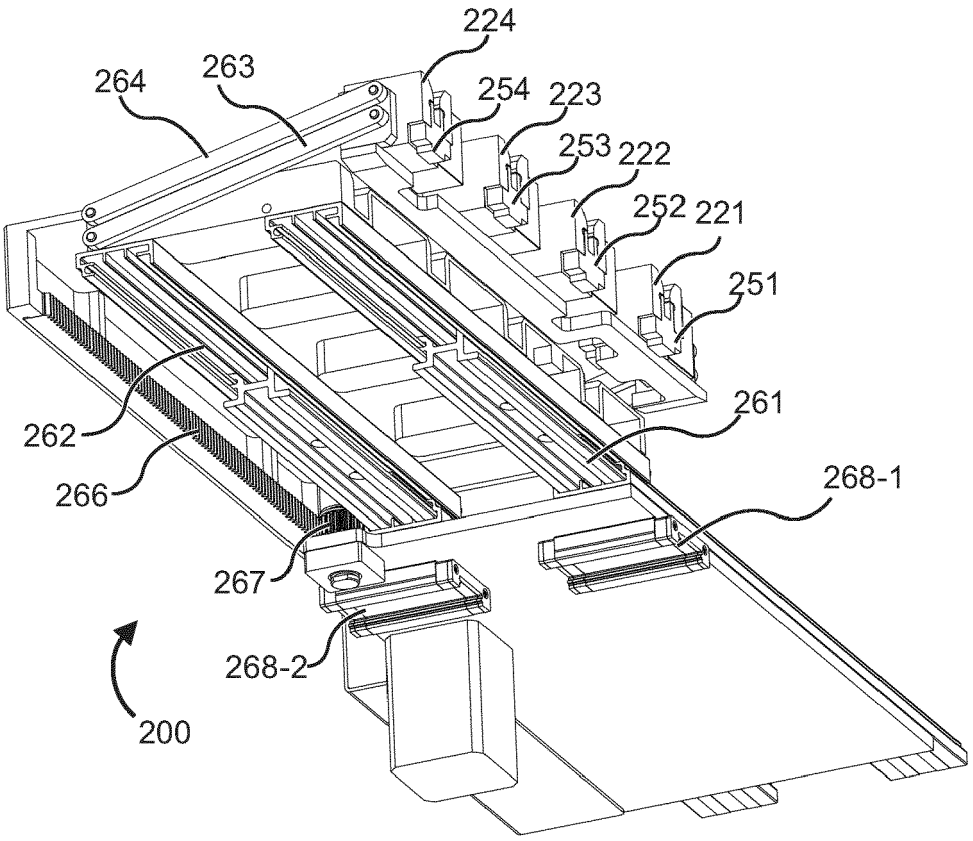
232
231
269

Fig. 2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221
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261
266
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267
268-2
200

Fig. 3

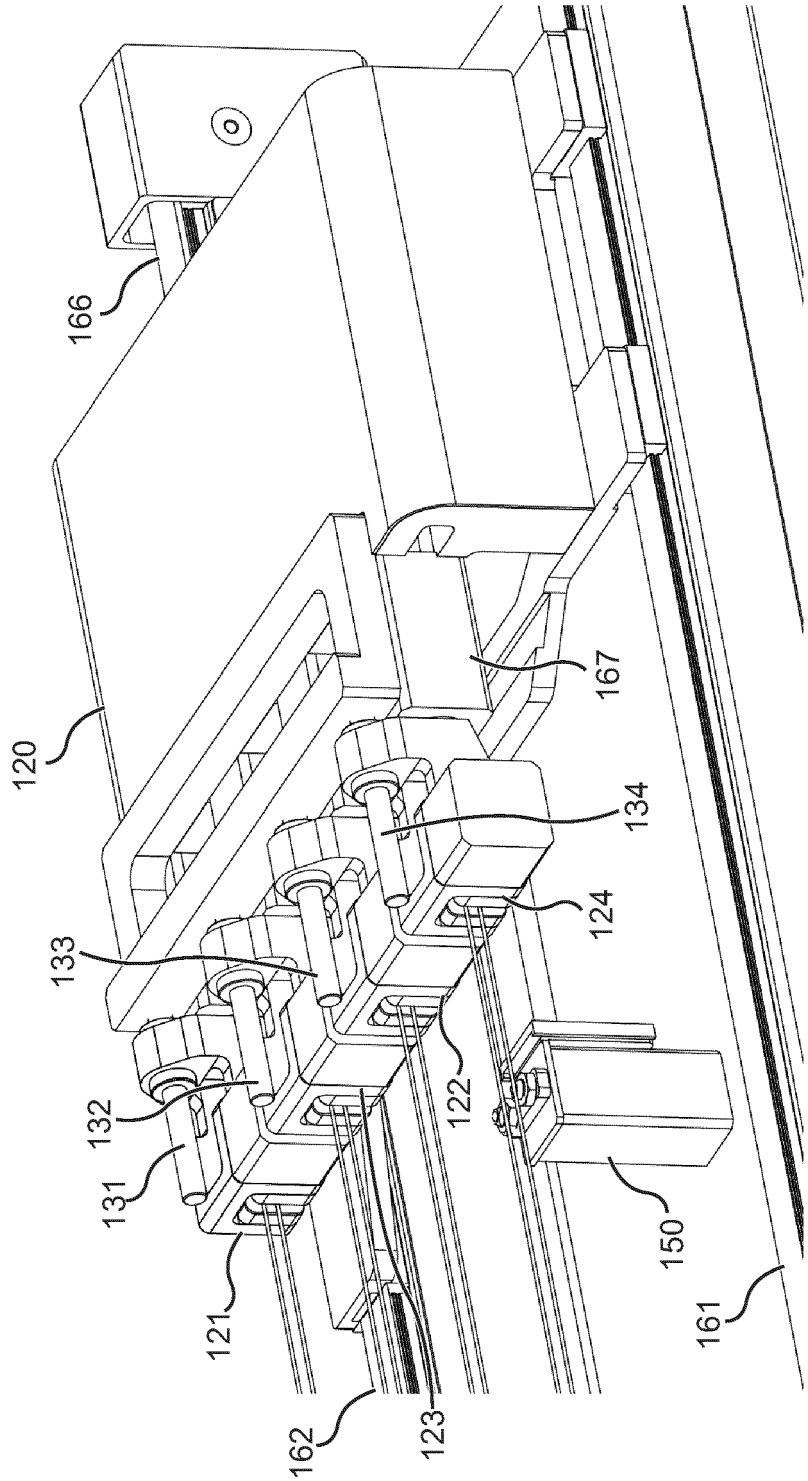

Fig. 4

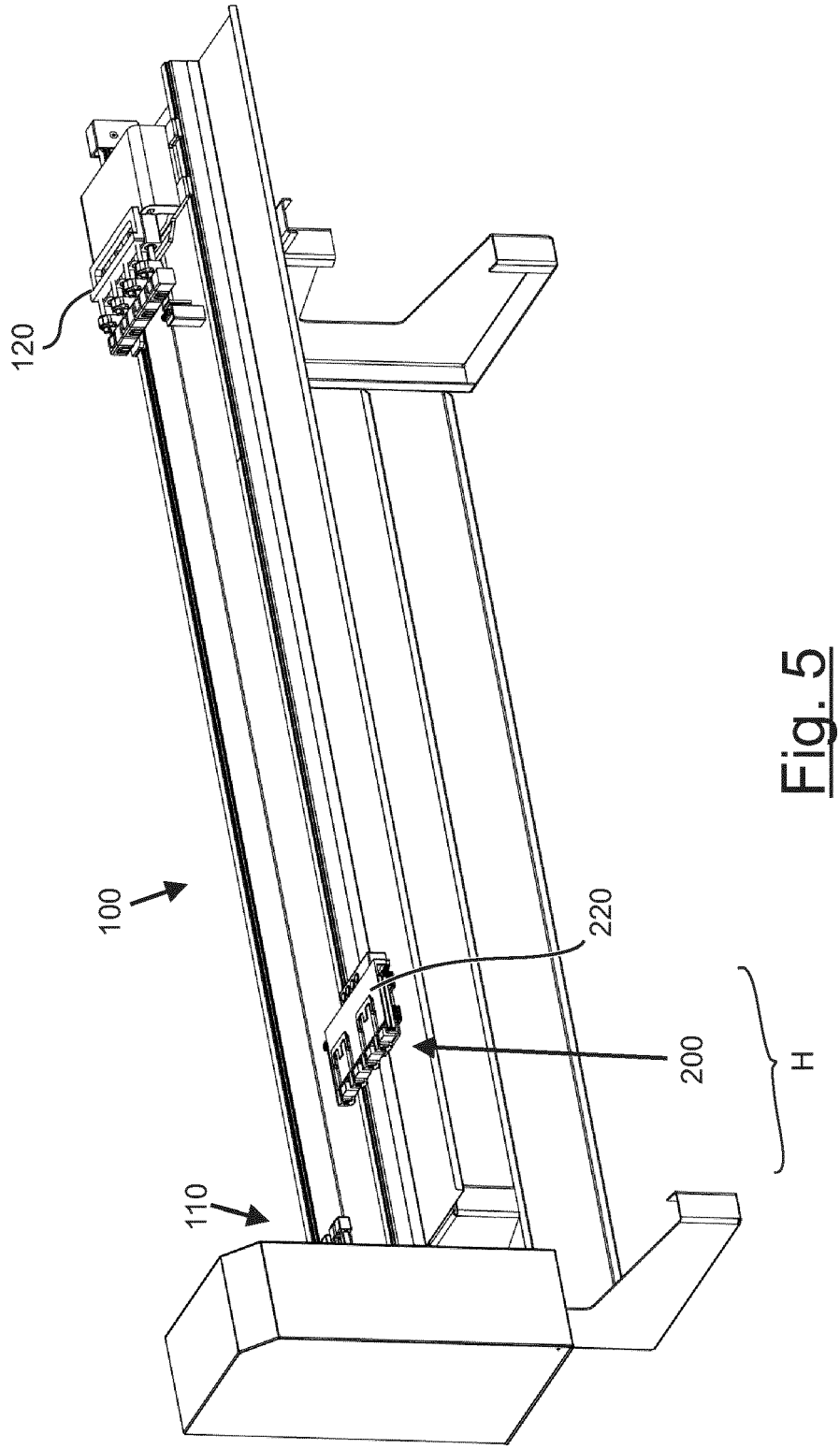

Fig. 5

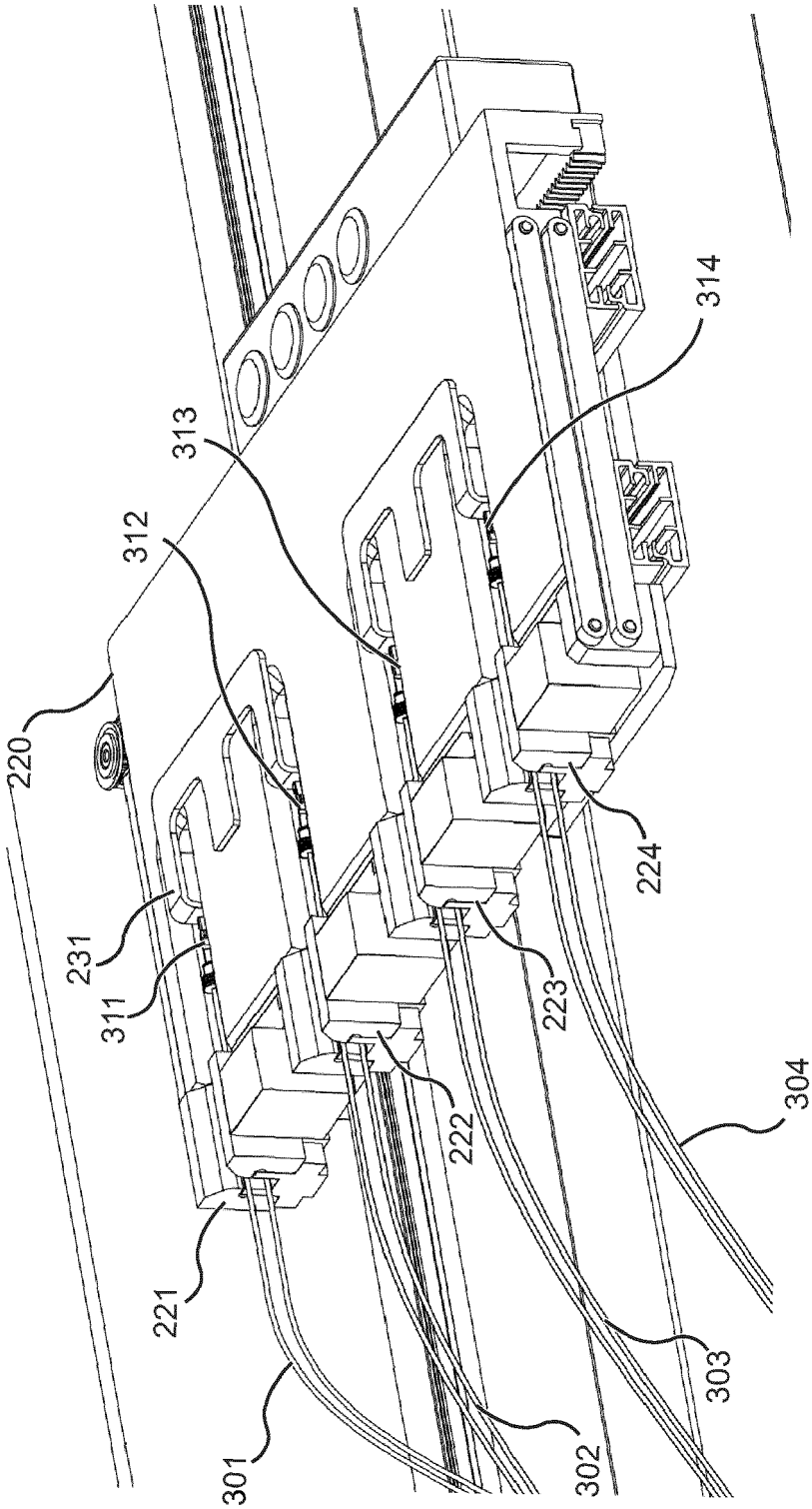

Fig. 6

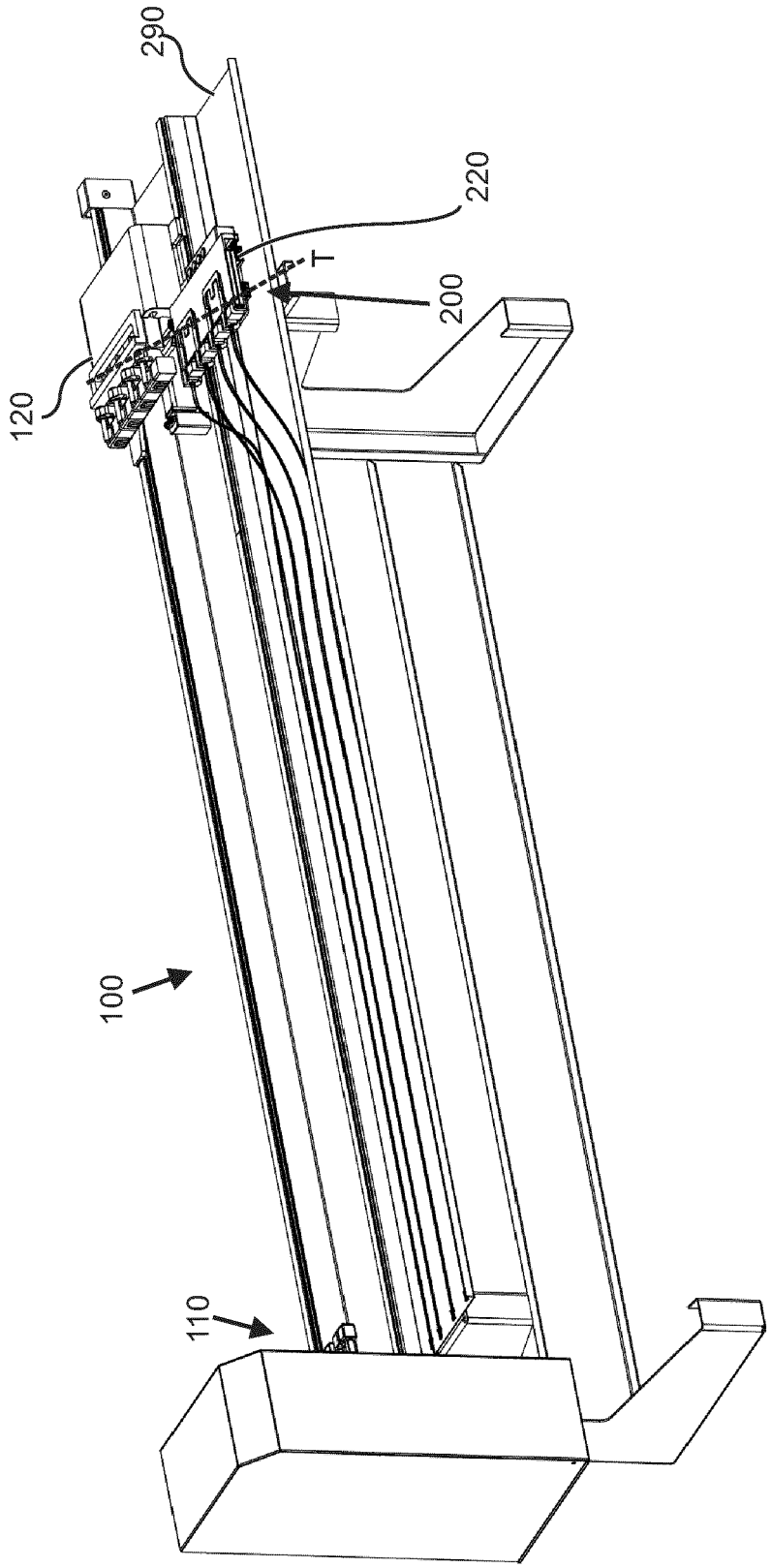

Fig. 7

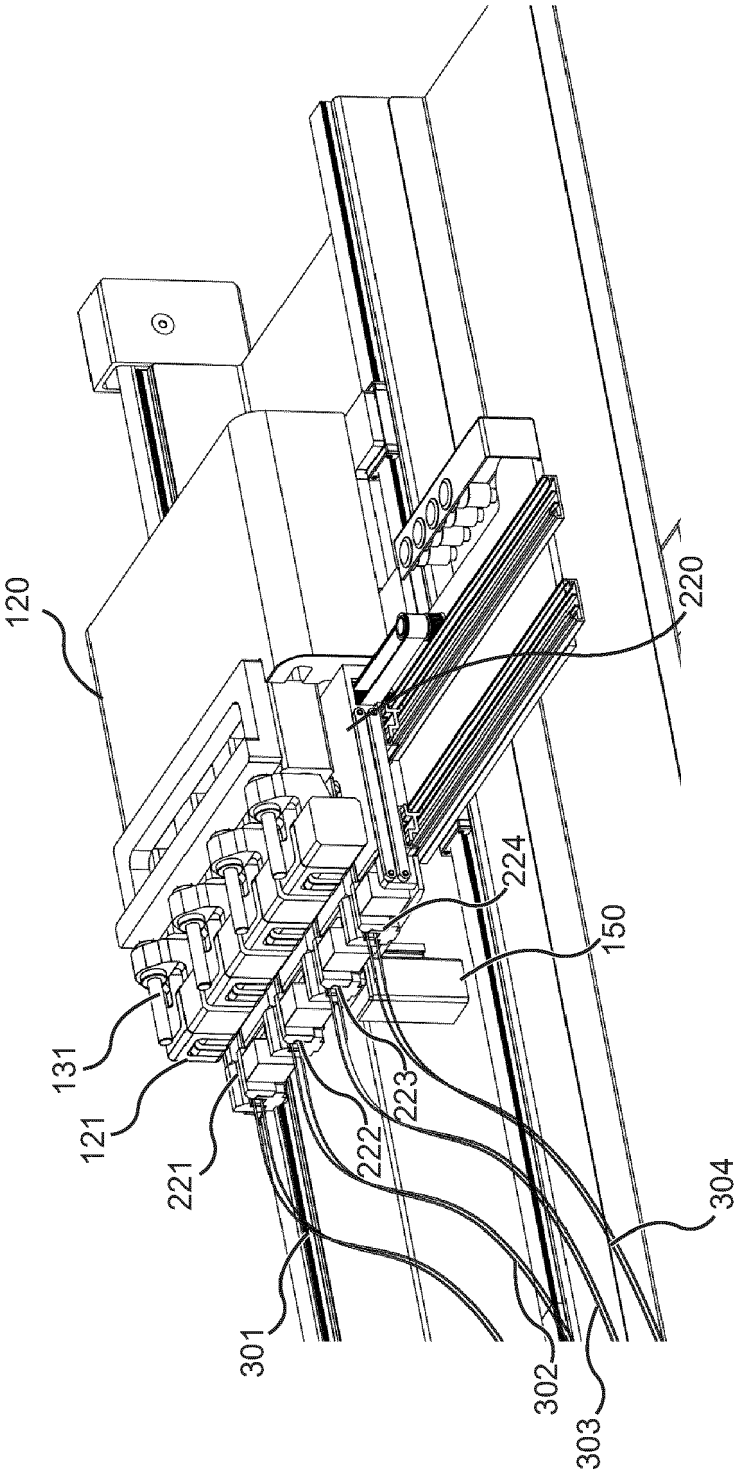

Fig. 8

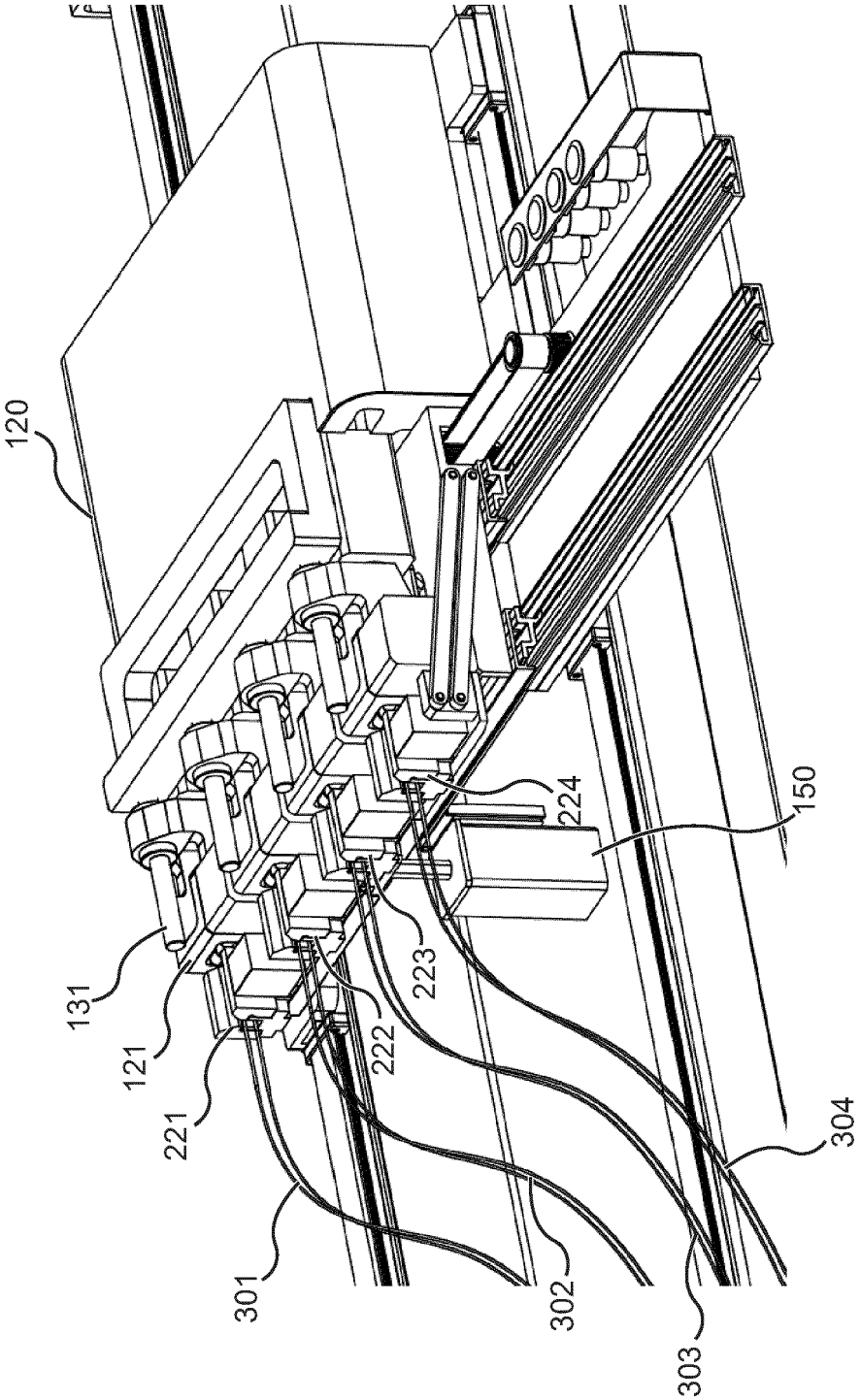

Fig. 9

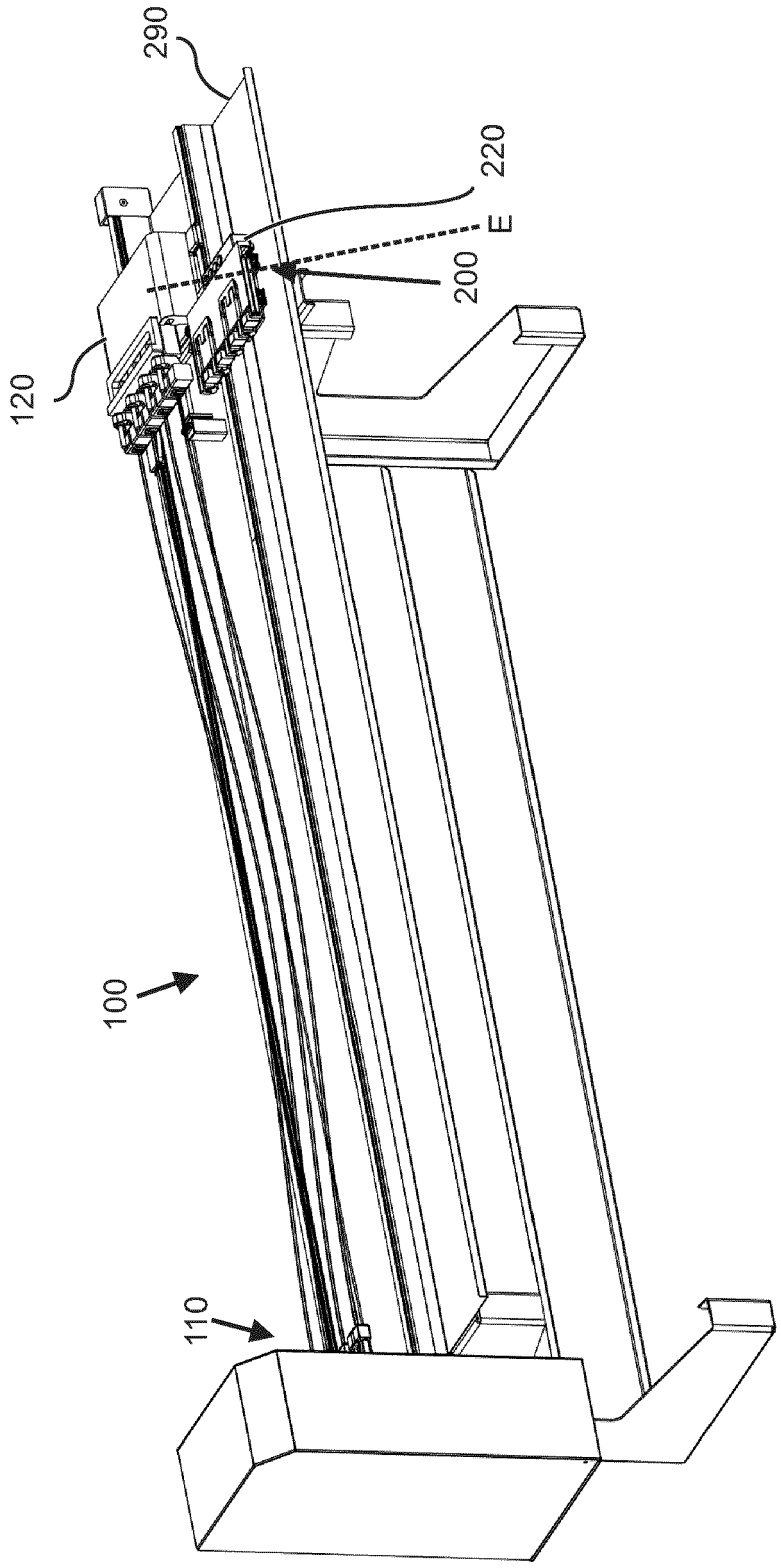

Fig. 10

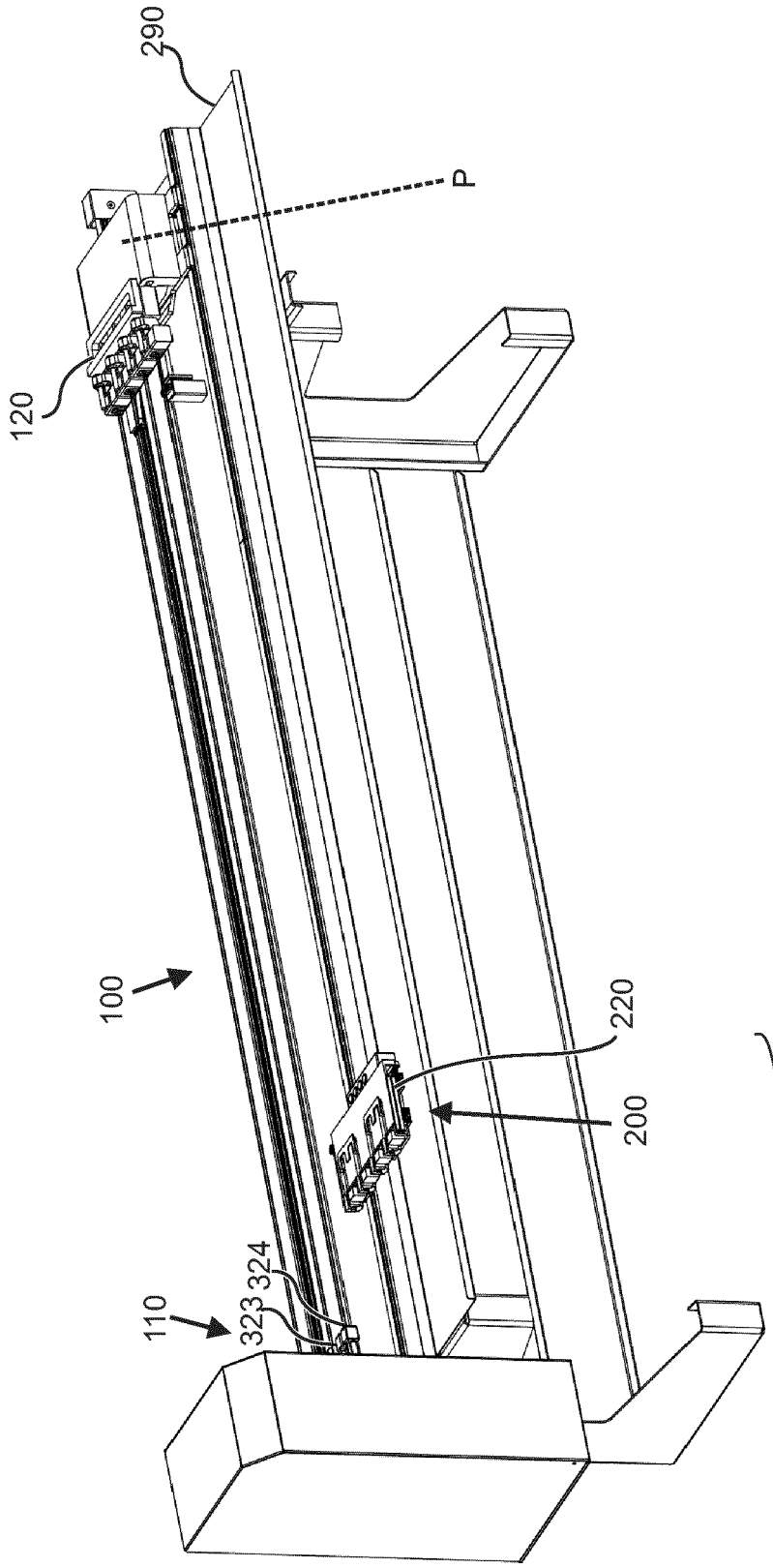

Fig. 11

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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 4921

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 November 2020	Bossi, Paolo

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