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(54) Benævnelse: **Anlæg til fremstilling af armeringskurve til tårnsegmenter af vindenergianlæg**

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The present invention relates to a system for producing reinforcing cages for wind turbine tower segments, wherein a reinforcing cage has in each case essentially horizontally oriented ring segments and essentially vertically oriented stiffening elements (see e.g. DE 36 34 736 A1 which is of a generic kind).

5 Towers such as those which are used, *inter alia*, for wind turbines often have a
wall made from concrete or reinforced concrete. In particular in the case of
dynamically loaded towers, which applies to the majority of towers owing to the
effect of the wind, stiffening structures, so-called reinforcing cages, are
additionally provided inside the tower wall in order to improve stability. A tower
10 hereby has a segmental structure, i.e. a tower is composed of multiple
superposed essentially ring-shaped tower segments.

In the production of such tower segments, the reinforcing cage is first produced and concrete is then poured into formwork provided for this purpose and left to set.

15 In known devices for producing reinforcing cages for tower segments, a support structure is provided which holds a plurality of bars, so-called rakes. These bars each have holders for holding reinforcing steel wire, wherein the reinforcing steel is passed around the support structure or the support structure is set in rotation in order to form ring elements. These ring elements are connected to bracket-like (steel) stiffening elements which extend essentially perpendicularly to the rings or 20 essentially vertically, as a result of which a grid-like reinforcing cage is formed.

The reinforcing steel wire is either passed around a stationary support structure in a circular motion or, which is preferable, is situated in a stationary feed unit and is pulled out of the holder by the support structure which can be driven in 25 rotation and is applied around the support structure owing to the rotational motion of the latter. During the whole time, the shape of the ring-shaped steel strands is stabilized by the support structure and the bars by means of multiple spokes which extend between the support structure and the bars. In order to remove the reinforcing cages from the device, in known systems the spokes must each be 30 removed or the stabilizing bars are unhooked individually and manually from the finished cage.

Depending on the size of the tower segments to be produced, the reinforcing cages already have a considerable weight and, depending on the tower segment, sizable dimensions. A reinforcing cage has, for example, for the lowest, i.e. largest tower segment of a type E126 wind turbine from the ENERCON company, 5 a diameter of approximately 14m, a height of approximately 3.7m and a weight of approximately 8.5t. Because of its grid-like structure and the enormous dimensions, during manufacture reinforcing cages can only be handled with difficulty using conventional crane systems.

10 A gripping device for handling such reinforcing cages is known from DE 10 2012 221 453.

15 As well as handling the reinforcing cages, in the known manufacturing environments there is, however, a need to design the connection of the essentially vertical elements to the essentially horizontal ring elements of the reinforcing cages more efficiently and at the same time to be able to handle them using the known gripping device referred to above.

The object of the invention is thus to provide a system of the type described at the beginning which ensures efficient production of the reinforcing cages. In particular, the object of the invention is also to be able to use said system in combination with, for example, the above described known gripping device.

20 The object on which the invention is based is solved by a system according to claims 1 or 2.

25 The invention is based on the recognition that, by using a first and a second handling robot, the number of manual work steps can be reduced, overall working safety is increased, and improved work planning is enabled. It has surprisingly proven to be the case that, despite the complex structure of the system and the many degrees of freedom during operation, it is possible to produce reinforcing cages in an efficient manner in terms of time.

According to the present invention, different types of stiffening elements can be formed in order to become part of the reinforcing cage. According to a first aspect, the stiffening elements are formed from a helically bent endless material. The stiffening elements are particularly preferably formed from a single helically 5 bent steel wire that runs around the complete circumference of the ring elements. This structure is also called an upright helix. Such a design of the stiffening elements has the advantage that a bending and welding device for supplying the stiffening elements that is separate and hence has associated transport costs can be dispensed with.

- 10 The first handling robot is preferably configured so as to form and arrange this structure along the essentially horizontal ring elements.

According to a preferred embodiment, the first handling robot has bending means and interacts with a feed unit which feeds the endless material to the bending means, wherein the bending means are configured so as to bend the fed endless 15 material in such a way that the stiffening means are formed helically.

- 15 The bending means preferably have deflecting rollers between which the endless material is passed, wherein the positions of the deflecting rollers relative to one another can be modified. The positions of the deflecting rollers relative to one another can be modified in such a way that different bending radii and bending 20 directions can be introduced into the endless material.

The arrangement of the deflecting rollers can, for example, take the form of tube bending tools.

- 25 In another preferred embodiment, the bending means are arranged so as to be stationary on the cage production system, wherein a handling robot preferably does not undertake the bending itself but only the handling of the bent reinforcing steel.

According to a second aspect of the invention, the stiffening elements are designed as separate, preferably closed brackets. This design has the advantage

that the arrangement of the individual stiffening elements around the ring elements can be handled in a more flexible manner and the handling process can be managed more simply. In the design according to this aspect of the invention, the stiffening elements are prefabricated in a separate production process and

5 then held in stock in large quantities.

In a preferred embodiment, the first handling robot has gripping means for non-slip grasping and removal of the stiffening elements from a stocking unit. Non-slip is hereby understood to mean that the gripping means grip the stiffening elements either in an interlocking fashion or force-locking fashion in such a way

10 that, taking into account the acceleration to be expected when the handling robots move, static friction occurs between the gripping means and the stiffening elements but dynamic friction does not, and of course the gripping means also do not release the stiffening elements.

15 The gripping means are preferably configured so as to grip the stiffening element at opposite ends of the stiffening element in each case on the inside of at least one corner.

According to a further preferred embodiment, the gripping means have a first and second pivotable coupling link which is configured so as to grip the stiffening element in each case at at least one corner by means of pivoting.

20 The coupling links preferably each have a guide roller for gripping the stiffening elements, preferably on the inside, at a corner, and preferably a supporting section or a further roller at an opposite end of the coupling link. The supporting section or the further roller are preferably each arranged in such a way that, when the coupling link is pivoted, a sufficient spreading force is exerted on the

25 stiffening element to allow the first handling robot to lift, lower and displace the stiffening element in a non-slip manner.

The invention is preferably further developed by the system having an electronic control unit which is configured so as to control the first and second handling robots for supplying the stiffening elements in a coordinated manner and for

connecting the stiffening elements to the ring elements. To do this, the electronic control unit preferably has one or more computer-assisted workstations which are configured so as to import and process a virtual representation of the reinforcing cage to be produced and of the system producing the reinforcing cage, including

5 the handling robots. The virtual representation can be supplied in the form of CAD data and/or CAD/CAM data. Data sets which link a specific movement pattern of the handling robots to a respective type of reinforcing cage to be produced are preferably stored in the electronic control unit. Reinforcing cages have different sizes depending on which tower segment they are to be used for.

10 The sizes can, for example, be stored in data memories and the electronic control unit is preferably configured so as to access them, read the corresponding data sets and convert them into operating instructions for the first and second handling robots.

In a preferred embodiment of the invention, the receiving area is arranged on a

15 rotatable platform. The first and second handling robots are preferably arranged in a fixed location adjacent to the platform and/or can preferably be adjusted radially with respect to the centre point of the platform. Because the handling robots are arranged adjacent to the preferably rotatable platform, an improved gain in space is obtained for the production site. Reinforcing cages for tower

20 segments have an essentially cylindrical or frustoconical design so that rotation of the reinforcing cages on the receiving platform does not require any additional space in any direction.

According to a further preferred embodiment, the receiving area is configured in order to interact with a gripping device for handling a reinforcing cage. The

25 gripping device is preferably designed according to DE 10 2012 221 453.

The first handling robot is furthermore preferably configured so as to bring the stiffening elements to bear against the ring elements in an essentially vertical orientation. It is hereby irrelevant if individual ring elements are not brought to bear against the stiffening elements. The crucial thing is that the stiffening

30 elements and ring elements which are brought to bear with one another are those where a connection is subsequently to be effected by the second handling robot

at the points where they meet. According to the invention, the phrase "essentially vertical" is also understood to mean at such an angle of inclination to the vertical as can arise from an oblique helical path, for example in the region of ± 1 to 10° .

According to a further preferred embodiment of the invention, the second
5 handling robot has a pivotable working head on which a connecting means is
arranged which is selected from a list consisting of:

- adhesive dispensing device,
- welding device,
- soldering device,
- 10 - device for automatically twisting metal wires.

The device for automatically twisting metal wires is preferably designed as known from DE 10 2012 216 831.

The above embodiments have each referred to ring elements generally. They can
15 be understood as a first set of ring elements when, in a preferred embodiment,
the system has a third handling robot for supplying a second set of essentially
horizontally oriented, preferably outer ring elements, wherein the ring elements
are designed as separate, preferably closed rings or are designed as helically
bent endless material. The electronic control unit is preferably likewise configured
20 so as to also control the third handling robot in a coordinated fashion with the first
and second handling robots, in particular based on a corresponding virtual
representation.

The third handling robot preferably has a guide device, preferably with one or
more guide rollers, and interacts with a feed unit which feeds the endless material
25 to the guide device, wherein the guide device is configured so as to guide the fed
endless material in such a way that the second set of ring elements has a helical
design.

The second handling robot is preferably moreover configured so as also to
connect the second set of ring elements to the stiffening elements.

The electronic control unit is preferably configured so as to control the second and third handling robots, preferably all the handling robots of the system, in order to supply in a coordinated fashion the second set of ring elements and to connect the stiffening elements to the second set of ring elements. Reference is 5 hereby preferably made to the same means and resources as with respect to the first and second handling robots.

The invention is explained in detail below with the aid of preferred exemplary embodiments and with reference to the attached drawings, in which:

Figures 1a, b show a schematic partial view of a system according to a first 10 exemplary embodiment,

Figures 2a-g show different working positions of the first handling robot according to the first exemplary embodiment,

Figures 3a-c show different schematic partial views of a system according to a second exemplary embodiment,

15 Figures 4a-c show different schematic partial views of a system according to a third exemplary embodiment,

Figures 5a,b show different working positions and schematic partial views of a third handling robot as examples for the second exemplary embodiment, and

20 Figures 6a-c show different working positions of a further handling robot for a system according to one of the exemplary embodiments, illustrated as examples of the first exemplary embodiment.

A system 1 according to a first exemplary embodiment of the invention is shown 25 in Figure 1a. The system 1 has a first handling robot 3 which is designed to form helically arranged stiffening elements 27 by means of corresponding bending means. The first handling robot 3 has a working head with a bending device 19.

The first handling robot 3 is arranged in Figures 1a, b on a support structure 5. This can be a pedestal as in Figures 1a, b or another support structure, as shown for example in one of the other exemplary embodiments.

The system 1 has a receiving area 7. The receiving area 7 is configured so as to 5 receive a gripping device 11. The gripping device 11 has coupling means, for example in the form of hook-shaped rake arms on which essentially horizontally oriented ring elements 13 are arranged in each case. The receiving area 7 is arranged on a preferably rotatable platform 9. The platform 9 is preferably connected to an electronic control unit by a data line so that the rotation can be 10 effected in a coordinated fashion by means of the electronic control unit, depending on the progress of the work of the handling robots 3 and 21.

The first handling robot 3 is connected, *inter alia*, to a feed unit 15 by means of 15 an electronic control device and interacts with the feed unit 15 so that the latter can feed to the handling robot 3 an endless material 17 to produce the helical stiffening elements 27.

The system 1 moreover has a second handling robot 21 which has a working head 25 with a connecting means, for example in the form of a welding wheel. The second handling robot 21 is preferably likewise connected to the electronic control unit and interacts in a coordinated fashion with the first handling robot 3 20 and the platform 9 in order to connect the generated stiffening elements 27 to the essentially horizontally oriented ring elements 13 which are held by the gripping device 11. The second handling robot 21 can be arranged, for example, on a support structure 23, adjacent to the receiving area 7, or on an alternative support structure together with the first handling robot, as shown for example in 25 the following exemplary embodiments.

The first handling robot 3 can move along multiple axes in order to enable the working head 19 to generate bends in the endless material 17 in such a way that the essentially vertically oriented stiffening elements 27 are formed. For this purpose, the working head 19 can also be reconfigured and repositioned, as is 30 shown in Figure 1b, and in particular as is illustrated in detail in Figures 2a to 2g.

The system moreover has an electronic control device 10 for controlling the handling robots 3, 21 on the platform 9 in a coordinated fashion.

A portion of the system 1 according to the first exemplary embodiment is shown in Figures 2a to 2g, in which the working head 19 of the first handling robot 3 is shown in operation. In the Figures, a first essentially vertically oriented stiffening element 27 has already been created, adjoining the ring elements 13 in the receiving area 7. The working head 19 has a base body 29 on which multiple deflecting rollers 31a,b, c (Figures 2c to 2g) are arranged. A first bend for a stiffening element 27 has been generated in Figure 2a. Starting from the situation in Figure 2a, in Figure 2b the endless material 17 is deformed further by adding a further bend. To do this, the first handling robot 3 has performed a corresponding pivoting motion about a working axis b. In order to complete the bending of the endless material 17, the first handling robot 3 briefly withdraws from the situation in Figure 2b and pivots the body of the handling robot 3 outwards so that the first handling robot 3 does not collide when the endless material 17 is then guided upwards to the point at which the next bend which needs to be made.

The working head 19 of the first handling robot 3, formed by bending means in the form of a bending device, has adjustable deflecting rollers 31a, b, c which are arranged on the base body 29. An example of altering the position of the rollers, in conjunction with a repositioning motion of the working head 19, is illustrated in Figures 2c to 2g.

In Figure 2c, the working head 19 on the first handling robot 3 is initially still situated in engagement with the endless material 17. In order to prevent twisting of the endless material 17 using the handling robot 3, in Figure 2d the working head 19 is pivoted about an axis c on the first handling robot 3 in the direction of the arrow 33 so that the rollers 31a, b, c are brought out of engagement with the endless material 17. Then, as can be seen in Figure 2e, the positions of the rollers 31a and 31c are altered in a first direction, whilst the deflecting roller 31b arranged between the deflecting rollers 31a, c is shifted in the opposite direction. The deflecting rollers 31a, b, c can be repositioned either steplessly or according to a pattern, for example by moving them into dedicated openings. Once the

repositioning is complete, as shown in Figure 2f, the working head 19 is pivoted again about the axis c in the direction of the arrow 35 so that the deflecting rollers 31a, b, c are again in engagement with the endless material 17. This situation is depicted in Figure 2g. In Figures 2c to 2g, the rotated position of the base body 29 relative to the first handling robot 3 is constant. It is, however, optionally also possible to pivot the base body 29 of the working head 19 about an axis a, as can be seen, for example, by comparing Figure 2b with Figure 2c.

Figures 3a, b show schematically a portion of a system 100 according to a second exemplary embodiment of the invention. The essential inventive features 10 are the same as in the first exemplary embodiment. In particular, the type of arrangement of a first handling robot 103 of the system 100 and a second handling robot 121 of the system 100 can in principle be swapped or combined with the type of arrangement for the system 1. On its working head 119, the first handling robot 103 of the system 100 has a gripping device by means of which 15 the handling robot 103 can grip stiffening elements 127 on the inside and hold them in a non-slip fashion. The stiffening elements 127 according to the second exemplary embodiment are separate, preferably closed brackets. The first handling robot 103 is designed to remove the bracket-like stiffening elements 127 from a stocking unit using the working head 119 designed as a gripping device, 20 bring them to bear against the ring elements 13 on the gripping device 11 of the system 100, and hold them there until the second handling robot 121 has connected the stiffening elements 127 to the ring elements 13 using its working head 125 designed as a welding device, for example as a welding wheel. In Figures 3a, b, the first handling robot 103 and the second handling robot 121 are 25 arranged on an annular platform 105 surrounding the gripping device 11 and the (unshown) rotatable platform 9 (Figure 1a). However, support structures like those for example in Figures 1a, b could also be chosen, in exactly the same way as a support structure like the platform 105 depicted here could be chosen in the first exemplary embodiment of the system 1 in Figures 1a, b.

30 The precise design of the stocking unit is not shown in this exemplary embodiment for reasons of clarity. It can, for example, be a stocking unit like the

stocking unit 204 from the exemplary embodiment of Figures 4a to 4c explained below.

In the situation in Figure 3a, the second handling robot 121 is positioned in such a way that a stiffening element 127 is connected to one of the ring elements 13 in 5 the upper area of the reinforcing cage to be created. On the other hand, in Figure 3b the second handling robot 121 is positioned such that the working head 125 can connect the stiffening element 127, in a lower area of the reinforcing cage to be produced, to a ring element in the gripping device 11, or alternatively effects a weld on the stiffening element 127 itself. During these processes, the first 10 handling robot 103 holds the stiffening element 127 in position in a non-slip manner. This happens by means of pivotable coupling links which are arranged at opposite ends of the working head 119. Figure 3c shows the coupling link 141, although it is covered by the working head 125 of the second handling robot 121. The coupling link with its component parts is likewise also explained in greater 15 detail in an exemplary embodiment which is still to be discussed below.

The coupling link 141, which can be seen in Figure 3c, has at its first end a guide roller 145 which is configured so as to be inserted into the bend, and therefore the corner, of a stiffening element 127 and to grasp the stiffening element there. At the opposite end of the coupling link 141 from the guide roller 145, a support 20 section 147 is arranged which is configured so as to exert, when the coupling link 141 is pivoted together with the guide roller 145, a spreading force on the stiffening element 127 which is great enough to be able to hold the stiffening element 127 in a non-slip manner.

The coupling link 141 can preferably be displaced by means of an actuator 143.

25 A system 200 for producing reinforcing cages according to a third exemplary embodiment is shown in Figures 4a to 4c. The third exemplary embodiment is very similar in structure to the second exemplary embodiment so reference is only made to structural differences. In contrast to the system 100, the system 200 has a height-adjustable portal 206 on which a second handling robot 221 is 30 arranged so that its height can be altered. A first handling robot 203 is mounted

on a support structure 205 separately from the second handling robot 221. The system 200 has a stocking unit 204 for stiffening elements 127. The first handling robot 203 is configured so as to remove these stiffening elements 127 from the stocking unit 204 and place them against the ring elements 13 which are held on

5 the gripping device 11 and are arranged in the receiving area 7 on a rotatable platform 9. This removal process is shown by way of example in Figure 4a. In Figure 4b, which shows the same system 200 from Figure 4a from a different point of view, the first handling robot 203 has brought a previously removed stiffening element 127 to bear against the ring elements 13 on the gripping device

10 11. Starting from the operating situation in Figure 4b, the second handling robot 221 is configured so as to shift heightwise along the portal 206 to the appropriate point and then bring a working head 225 into position, which creates a connection of the stiffening element 127 in each case to a section of a ring element 13 at different heights along the reinforcing cage which is to be produced.

15 In the exemplary embodiments shown hereabove, the essentially horizontally oriented ring elements 13 were the ring elements for a so-called internal helix of the reinforcing cage to be produced. It is likewise within the scope of the invention that these ring elements represent a so-called external helix, wherein the stiffening elements could then be arranged on the inside with respect to these

20 ring elements. Not all combinations of corresponding shifts of the positions of the handling robots are shown here in order to make the view clear.

In order to remain within the abovedescribed exemplary embodiment of an internal helix for the essentially horizontally oriented ring elements 13, it is provided within the scope of a further exemplary embodiment, which is to be

25 understood as a supplement to all the exemplary embodiments shown above, but by way of example is only illustrated with the aid of the exemplary embodiment from Figures 3a to 3c, that the essentially horizontally oriented ring elements 13 represent a first set of ring elements. In Figures 5a and b, an automatic winding unit 150 is additionally provided in the system 100, which is configured so as to

30 supply a second set of essentially horizontally oriented ring elements 14 on an opposite side of the stiffening elements 127 (or also of the helically formed stiffening elements 27 in the first exemplary embodiment) with respect to the first

set of ring elements. In the exemplary embodiment shown in Figures 5a and 5b, the winding unit 150 has a guide device 153 which is configured so as to apply endless material, which can be the same endless material for the helically formed stiffening elements 27 of Figures 1a to 2g, annularly or spirally around the 5 stiffening elements 127. To do this, the winding unit 150 is shifted heightwise on a portal 151 whilst the platform 9 is rotated about a vertically oriented axis e together with the gripping device 11, the ring elements 13 and the stiffening elements 127. As can be seen from Figure 5b, the endless material is preferably supplied by a feed device in the form of a stocking unit 155 which can hold ready 10 a cylindrical spool of the endless material. The guide device can have multiple guide rollers which allow the endless material to be dispensed in a specific fashion in order to form the rings 14. The winding unit 150 is preferably connected via a data line to a central electronic control unit, for example the one mentioned above, which coordinates the work of the different system components such as the handling robots, winding unit and rotatable platform. 15 This control unit is indicated in Figure 1a.

The winding unit which is shown in Figures 5a, b can, for example, also be the feed device 15 which is used in the exemplary embodiment of Figures 1a to 2g in order to supply the endless material 17.

20 An additional option for a combination of features, given by way of example, of the abovedescribed different exemplary embodiments in Figures 6a to 6c is described below with reference to a further exemplary embodiment. The system 1 according to the exemplary embodiment from Figures 1a to 2g preferably has a further handling robot 61. The handling robot 61 in particular has an identical 25 design to the first handling robot 103 from the exemplary embodiment of Figures 3a to c. Although there is no need to supply prefabricated stiffening elements from a stocking unit in the system 1, this handling robot 61 can also advantageously be used in the system 1 by it engaging in the already formed helical stiffening elements 27 in order to stabilize them and hold them in a non-slip manner until the second handling robot 21 has carried out the necessary 30 work of connecting the stiffening elements 27 to the ring elements 13.

In Figures 6b to c, further details are shown with respect to the working head 63 of the handling robot 61, visible in Figure 6a and designed as a gripping device, which, to simplify the drawing, were omitted in the case of the working head 119 from the exemplary embodiment of Figures 3a to c and similarly in the exemplary 5 embodiment of Figures 4a to c. The coupling device, which has the reference numeral 67 instead of 141, is arranged on the working head 63 so that it can be shifted by means of an actuator 65. The supporting section now has the reference numeral 71 and the guide roller the reference numeral 69. The operating mode of the coupling link is shown by way of example in Figures 6b, c.

10 The gripping device 63 is first brought into the situation shown in Figure 6a. In this situation, the coupling link 67 shown in Figure 6b is situated in the "internal area" of a corner of a spiral of the stiffening elements 27. From this position, a piston rod 75 is extended in the direction of the arrow 73 by means of the actuator 65. According to Figure 6c, this has the consequence that the guide 15 roller 69 of the coupling link comes to bear against an end area 27a of the stiffening element 27 and, when the piston rod 75 continues to move, rolls in the direction of one of the corners caused by the bending. In Figure 6c, the guide roller 69 has reached the corner 27b caused by the bending. The piston rod 75 is displaced so far by means of the actuator 65 that the supporting section 71 20 arranged at the opposite end of the coupling link 67, with respect to the guide roller 69, bears against an essentially vertical section 27c of the stiffening element 27. In this position, the actuator 65 is, by virtue of the piston rod 75 being pushed out further, capable of exerting a spreading force on the stiffening element 27 by means of which the latter is fixed and stabilized. In this position, it 25 is possible for the stiffening elements directly adjacent to the held stiffening element 27, and including the stiffening element 27 itself, to be connected by the second handling robot 21.

For the sake of clarity, a spring return for the coupling link and different sensor means which are part of the system equipment and assist error-free and collision-free operation of the system have not been shown.

Patentkrav

1. Anlæg (1; 100; 200) til fremstilling af armeringskurve til tårnsegmenter af vindenergianlæg, hvor en armeringskurv har respektivt i det væsentlige horisontalt orienterede ringelementer (13, 14) og i det væsentlige vertikalt orienterede afstivningselementer (27; 127), og anlægget har:

5 - et optagelsesområde (7), som er tilpasset til at optage de, fortrinsvis indvendige, i det væsentlige horisontalt orienterede ringelementer (13) af armeringskurven,

10 - en første håndteringsrobot (3; 61; 103; 203) til tilvejebringelse og positionering af afstivningselementerne og

15 - en anden håndteringsrobot (21; 121; 221) til at forbinde ringelementerne med afstivningselementerne,

20 **kendetegnet ved, at** den første håndteringsrobot (3) med henblik på fremstilling af armeringskurve med afstivningselementer (27), som er udformet af et vindelformet bøjet endeløst materiale (17), har bøjningsmidler og samvirker med en tilførselsenhed (15), som tilfører det endeløse materiale til bøjningsmidlerne, hvor bøjningsmidlerne er indrettet til at bøje det tilførte endeløse materiale på en sådan måde, at afstivningsmidlerne dermed udformes vindelformet.

25 2. Anlæg (1; 100; 200) til fremstilling af armeringskurve til tårnsegmenter af vindenergianlæg, hvor en armeringskurv har respektivt i det væsentlige horisontalt orienterede ringelementer (13, 14) og i det væsentlige vertikalt orienterede afstivningselementer (27; 127), og anlægget har:

30 - et optagelsesområde (7), som er tilpasset til at optage de, fortrinsvis indvendige, i det væsentlige horisontalt orienterede ringelementer (13) af armeringskurven,

35 - en første håndteringsrobot (3; 61; 103; 203) til tilvejebringelse og positionering af afstivningselementerne og

- en anden håndteringsrobot (21; 121; 221) til at forbinde ringelementerne med afstivningselementerne,

35 **kendetegnet ved, at** den første håndteringsrobot (103; 203) med henblik på fremstilling af armeringskurve med afstivningselementer (127), der er udformet som separate, fortrinsvis lukkede, bøjler, har gribemidler til rutsjesikker griben og fjernelse af afstivningselementerne (127) fra en opbevaringsenhed

(204).

3. Anlæg ifølge krav 1 eller 2,
5 **kendeteget ved** en elektronisk styreenhed (10), som er indrettet til at styre den første og anden håndteringsrobot (3, 21; 61; 103; 121; 203; 221) for koordineret at tilvejebringe afstivningselementerne og forbinde afstivnings-elementerne med ringelementerne.
4. Anlæg ifølge et af de foregående krav,
10 **kendeteget ved, at** optagelsesområdet er anbragt på en drejelig platform (9), og fortrinsvis den første og anden håndteringsrobot er anbragt nabolig-gende til platformen.
5. Anlæg ifølge et af de foregående krav,
15 hvor optagelsesområdet er indrettet til at samvirke med en gribemidretning (11) til håndtering af en armeringskurv.
6. Anlæg ifølge et af de foregående krav,
20 **kendeteget ved, at** den første håndteringsrobot (3; 61; 103; 203) er indret-tet til at bringe afstivningselementerne i det væsentlige vertikalt orienteret i anlæg med ringelementerne.
7. Anlæg (1) ifølge krav 1 eller et af kravene 3 til 6, afhængigt af krav 1, **ken-deteget ved, at** bøjningsmidlerne har omstyringsruller (31 a, b, c), mellem hvilke det endeløse materiale føres igennem, hvor positionerne af omstyringsrullerne kan ændres i forhold til hinanden.
25
8. Anlæg (1) ifølge krav 1 eller et af kravene 3 til 7, afhængigt af krav 1, hvor bøjningsmidlerne er anbragt stationært på anlægget, hvor en håndteringsro-bot udelukkende overtager håndteringen af de bøjede ståltråde.
30
9. Anlæg ifølge krav 2 eller et af kravene 3 til 6, afhængigt af krav 2, **kende-teget ved, at** gribemidlerne har et første og andet svingbart koblingsled (141), som er indrettet til at gibe fat i afstivningselementet (127) i respektivt mindst et hjørne ved hjælp af svingning, hvor fortrinsvis koblingsleddene (141) har respektivt en føringssrolle (145) til at gibe fat i afstivningselementet
35

fortrinsvis indefra i et hjørne og fortrinsvis et støtteafsnit (147) eller en yderligere rulle på en modsat beliggende ende af koblingsleddet, anbragt på en sådan måde, at der ved svingning af koblingsleddet udøves en tilstrækkelig spredningskraft på afstivningselementet, at den første håndteringsrobot (103) 5 rutsjesikkert kan hæve, sænke, bevæge og rotere afstivningselementet (127) frit i rummet.

10 **10.** Anlæg (100; 200) ifølge et af de foregående krav, **kendeteget ved, at** den anden håndteringsrobot (121; 221) har et svingbart arbejdshoved (125; 225), på hvilket der er anbragt et forbindelsesmiddel, udvalgt fra listen bestående af:

- en klæbemiddelafgivelsesindretning,
- en svejseindretning,
- en loddeindretning,
- 15 - en indretning til automatisk snoning af metaltråde.

20 **11.** Anlæg (1; 100; 200) ifølge et af de foregående krav, hvor ringelementerne (13) i optagelsesområdet (7) er et første sæt ringelementer, og anlægget har en automatisk viklingsenhed (150) til tilvejebringelse af det første sæt og et andet sæt af i det væsentlige horisontalt orienterede, fortrinsvis udvendige ringelementer (14), hvor ringelementerne (14) er udformet som separate, fortrinsvis lukkede, ringe eller er udformet af et vindelformet bøjet endeløst materiale.

25 **12.** Anlæg (1; 100; 200) ifølge krav 11, **kendeteget ved, at** den automatiske viklingsenhed (150) har en føringsindretning (153) og samvirker med en tilførselsenhed (155), som tilfører det endeløse materiale til føringsindretningen (153), hvor føringsindretningen er indrettet til at tilføre det tilførte endeløse materiale på en sådan måde, at ringelementerne udformes vindelformet.

30 **13.** Anlæg (1; 100; 200) ifølge krav 11 eller 12, **kendeteget ved, at** den anden håndteringsrobot (21; 121; 221) er indrettet til at forbinde det andet sæt ringelementer (14) med afstivningselementerne (27; 127).

14. Anlæg (1; 100; 200) ifølge et af kravene 11 til 13,
kendtegnet ved, at den elektroniske styreenhed (10) er indrettet til at styre
samtlige håndteringsrobotter af anlægget samt den automatiske tilførselsen-
hed og drejelige platform for koordineret at tilvejebringe ringelementerne (14)
afstivningselementerne (27, 127) og at forbinde afstivningselementerne med
ringelementerne (14).

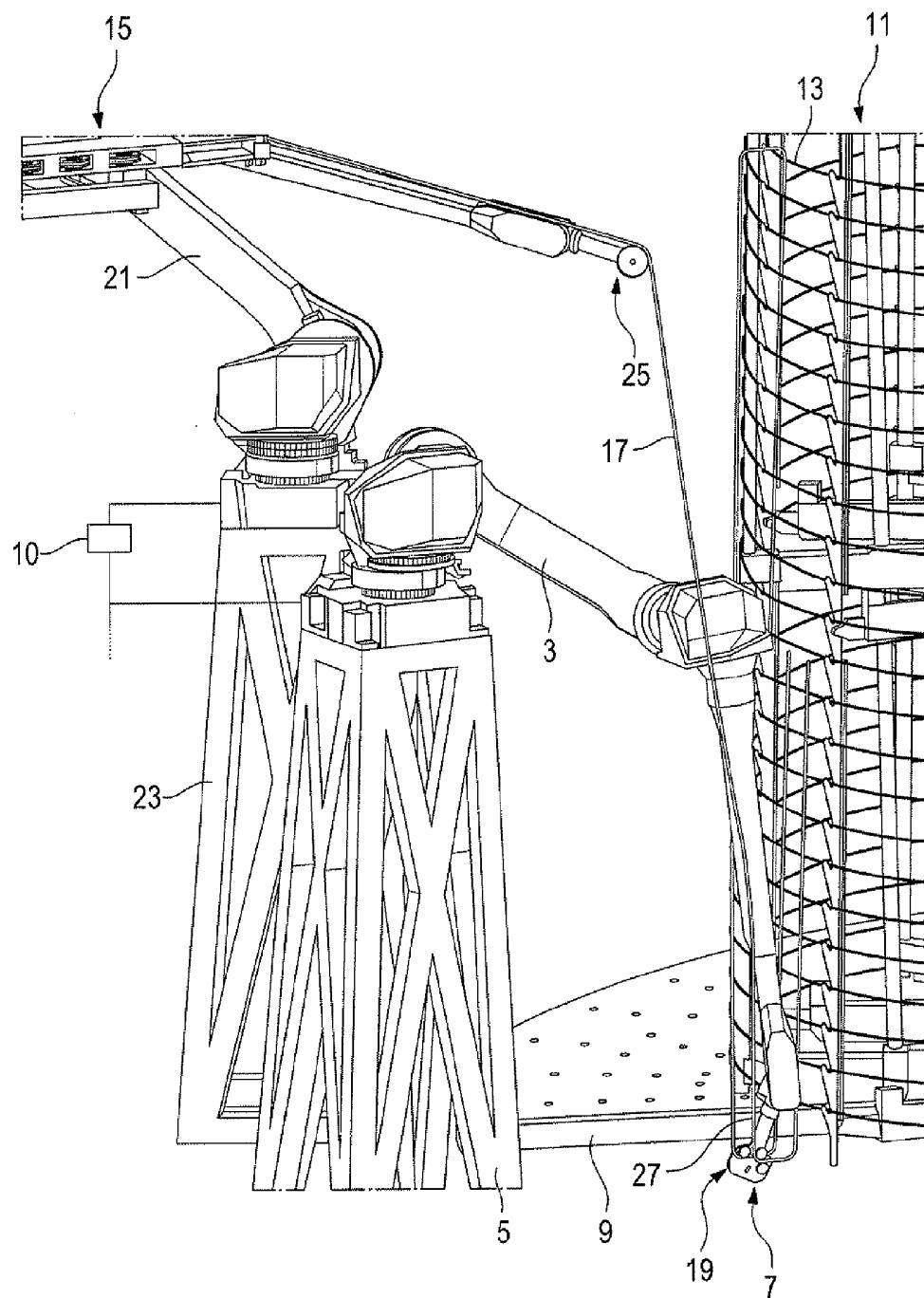


Fig. 1a

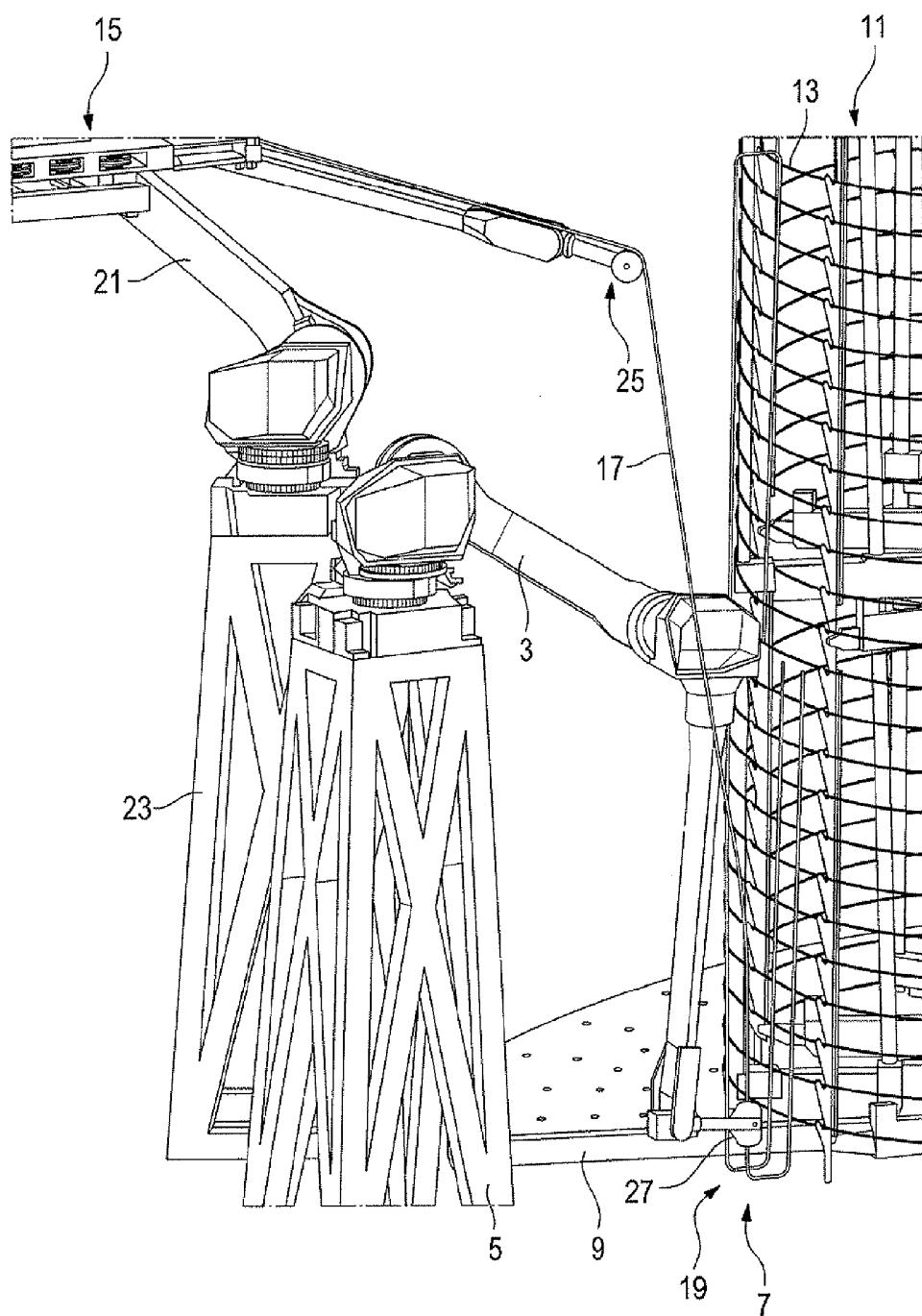


Fig. 1b

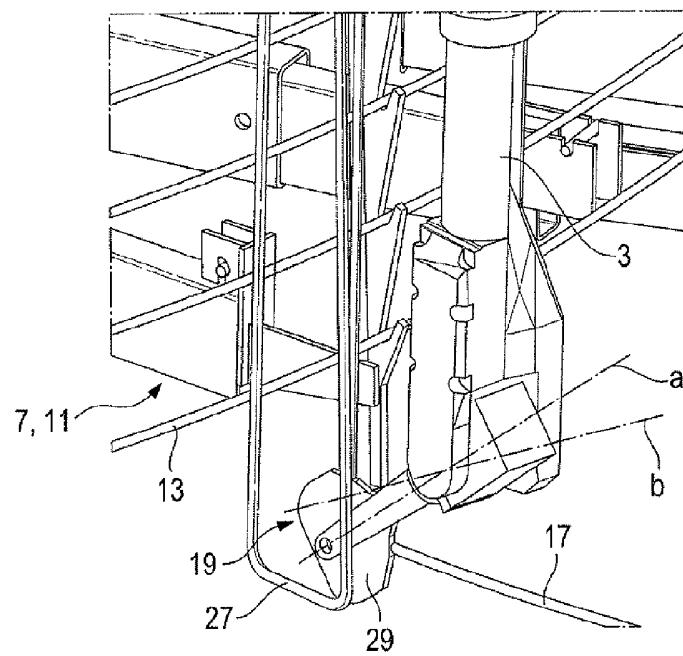


Fig. 2a

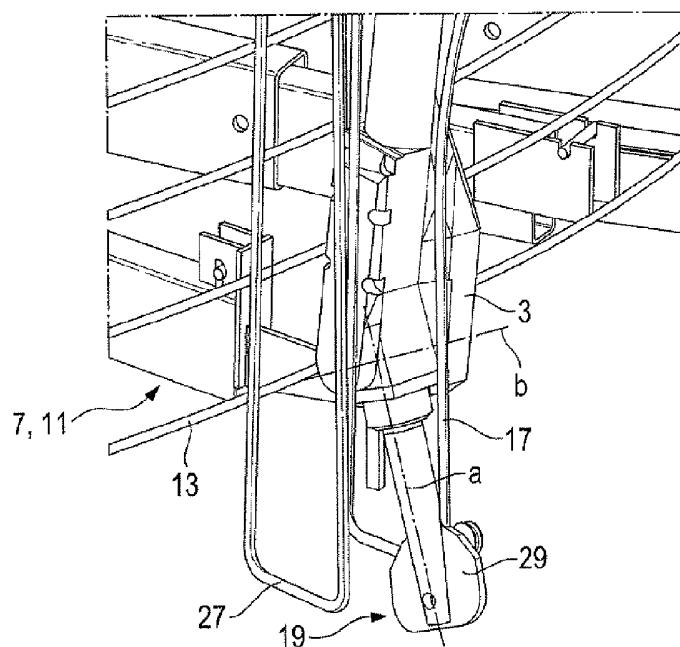


Fig. 2b

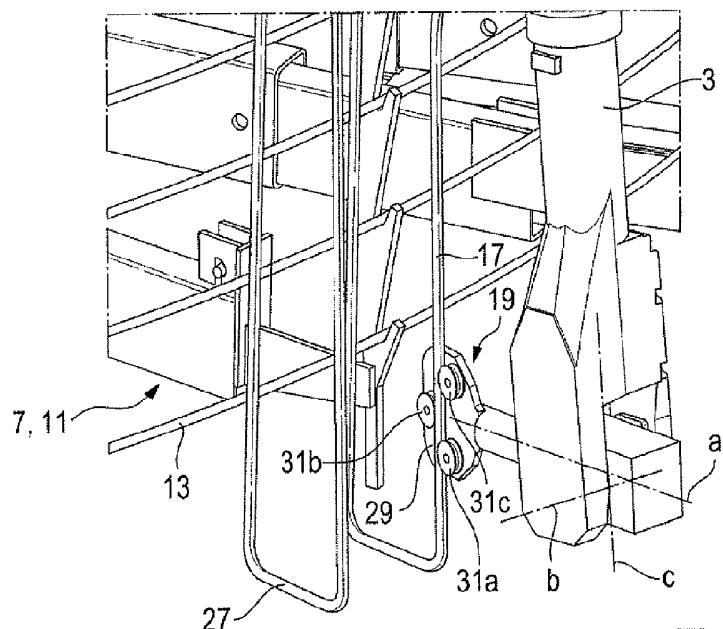


Fig. 2c

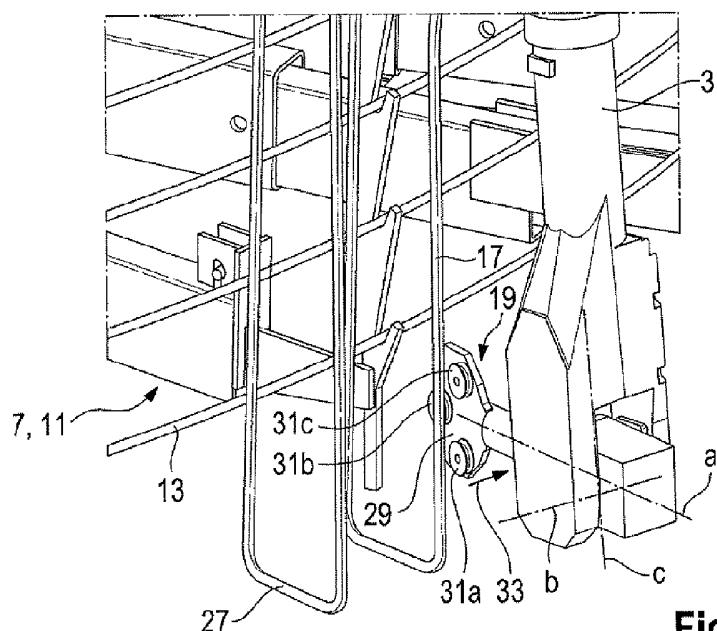


Fig. 2d

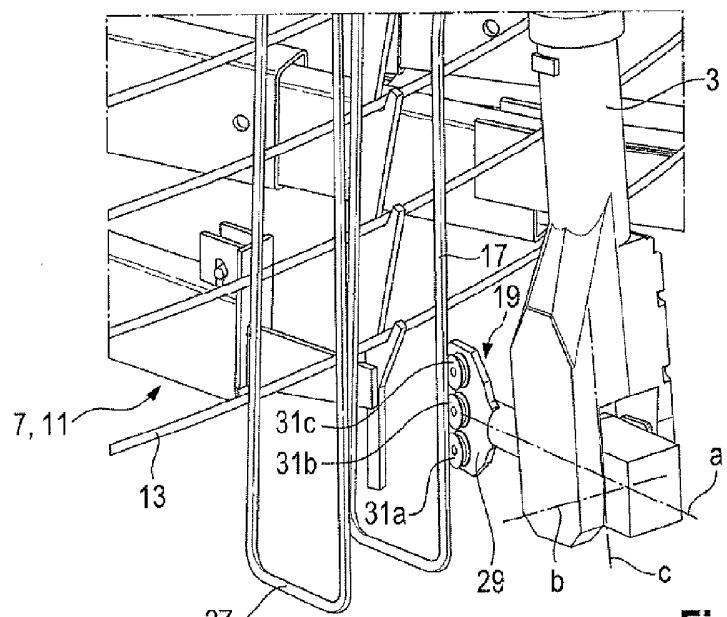


Fig. 2e

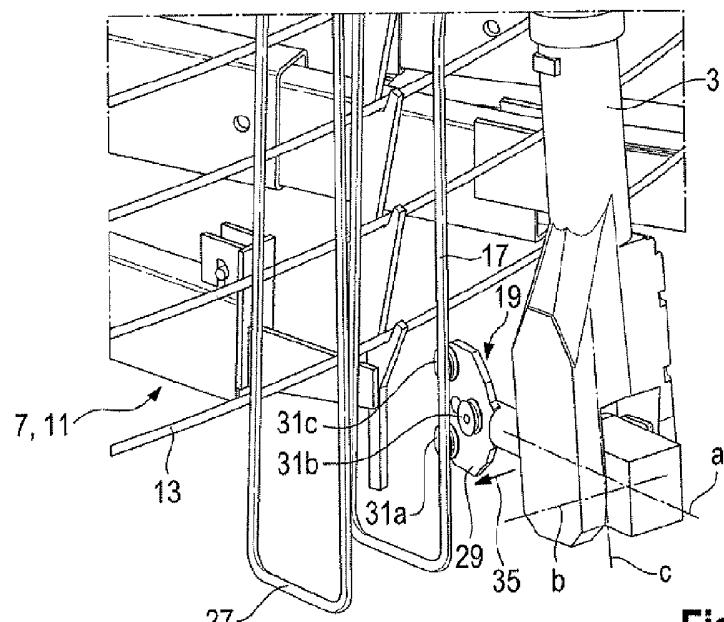


Fig. 2f

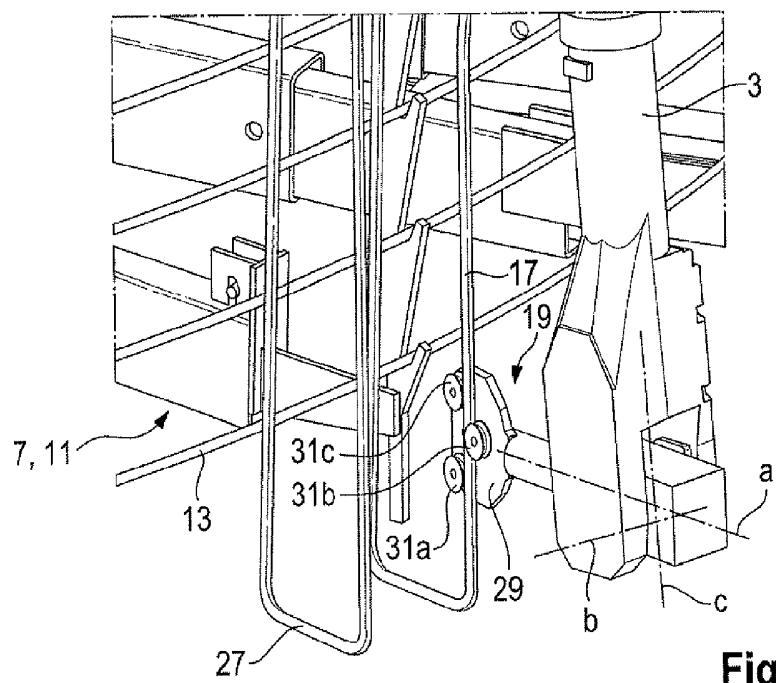


Fig. 3a

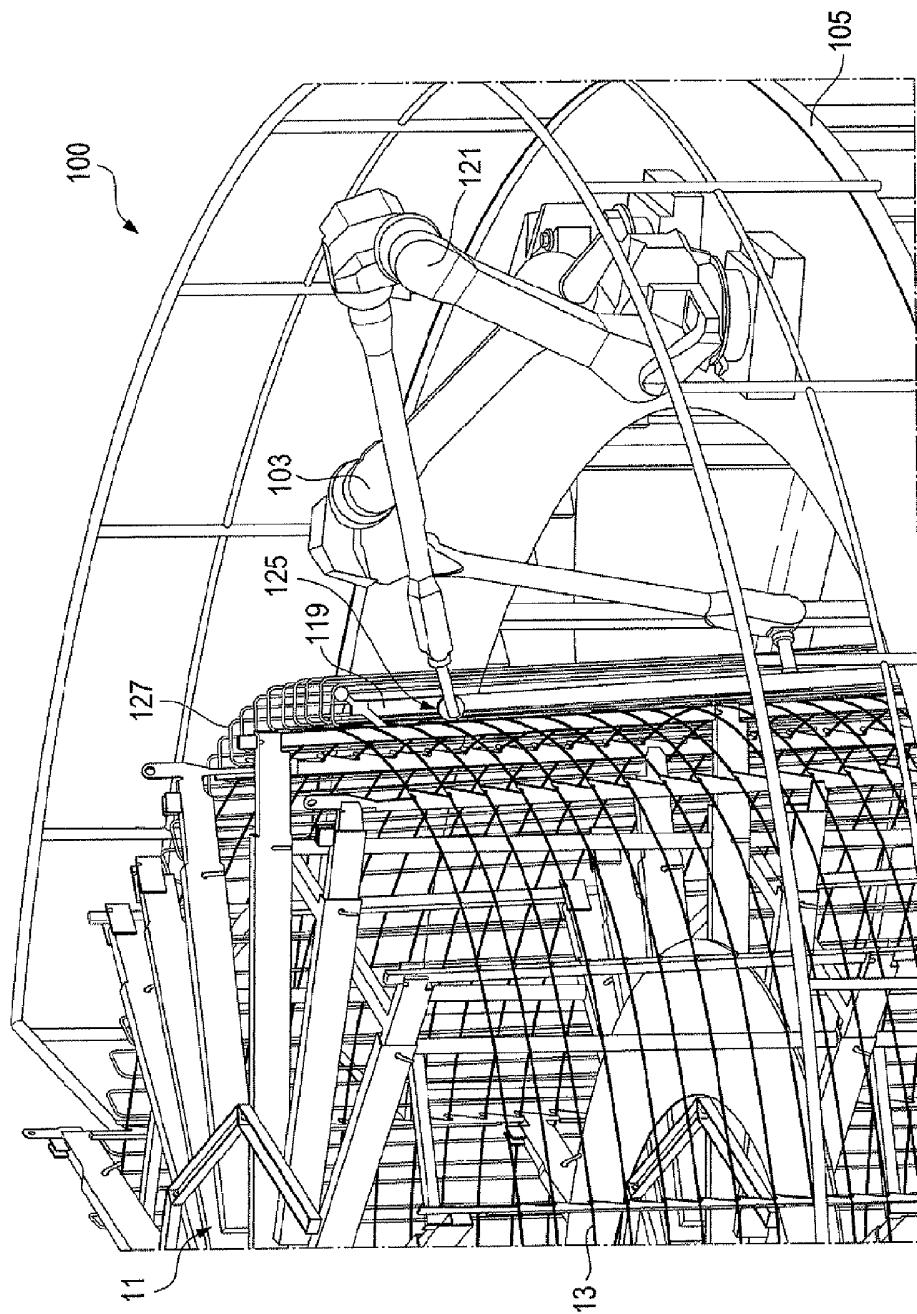
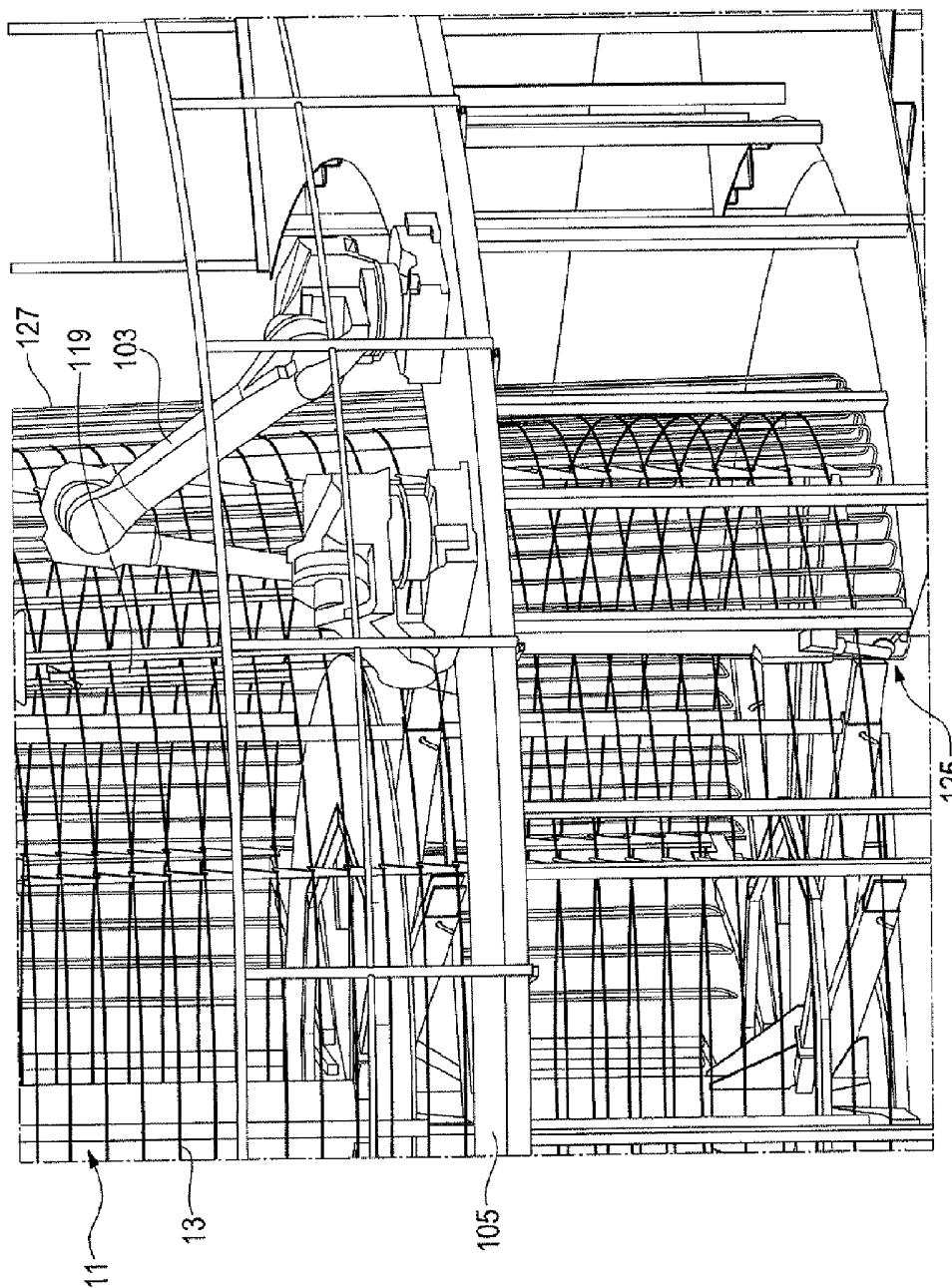


Fig. 3b



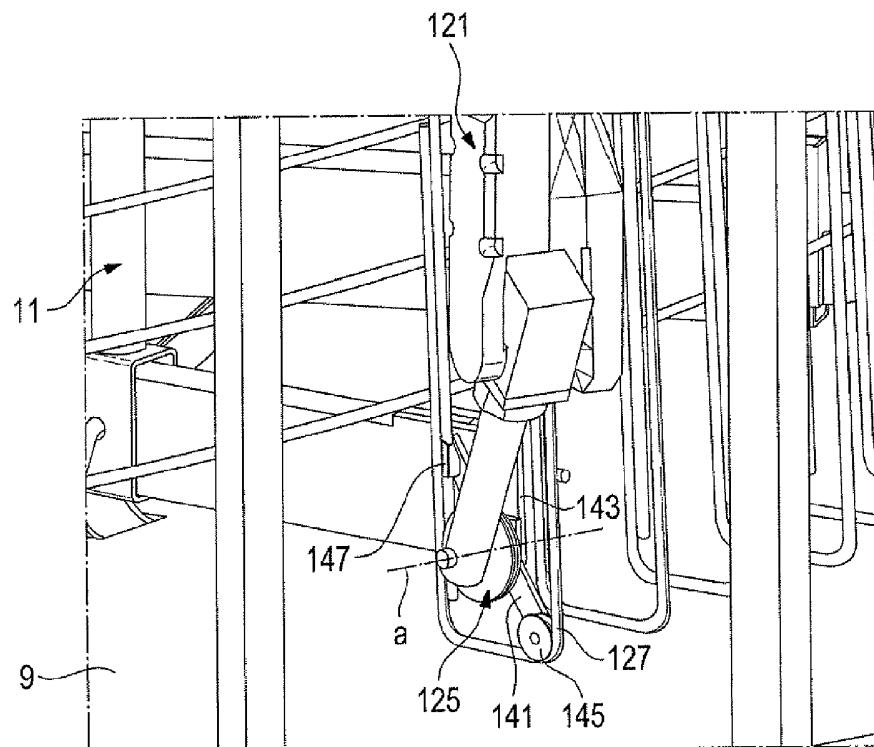
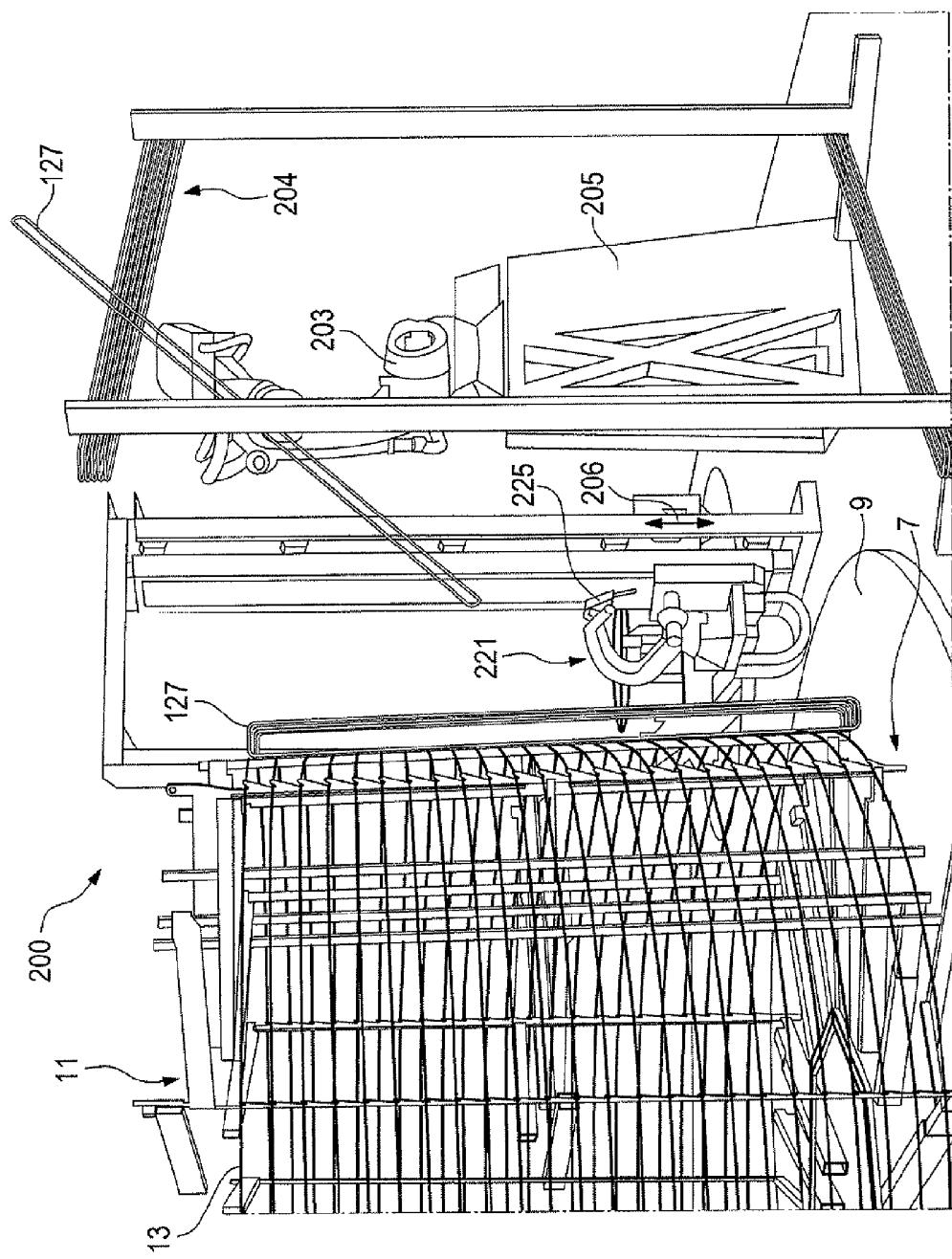
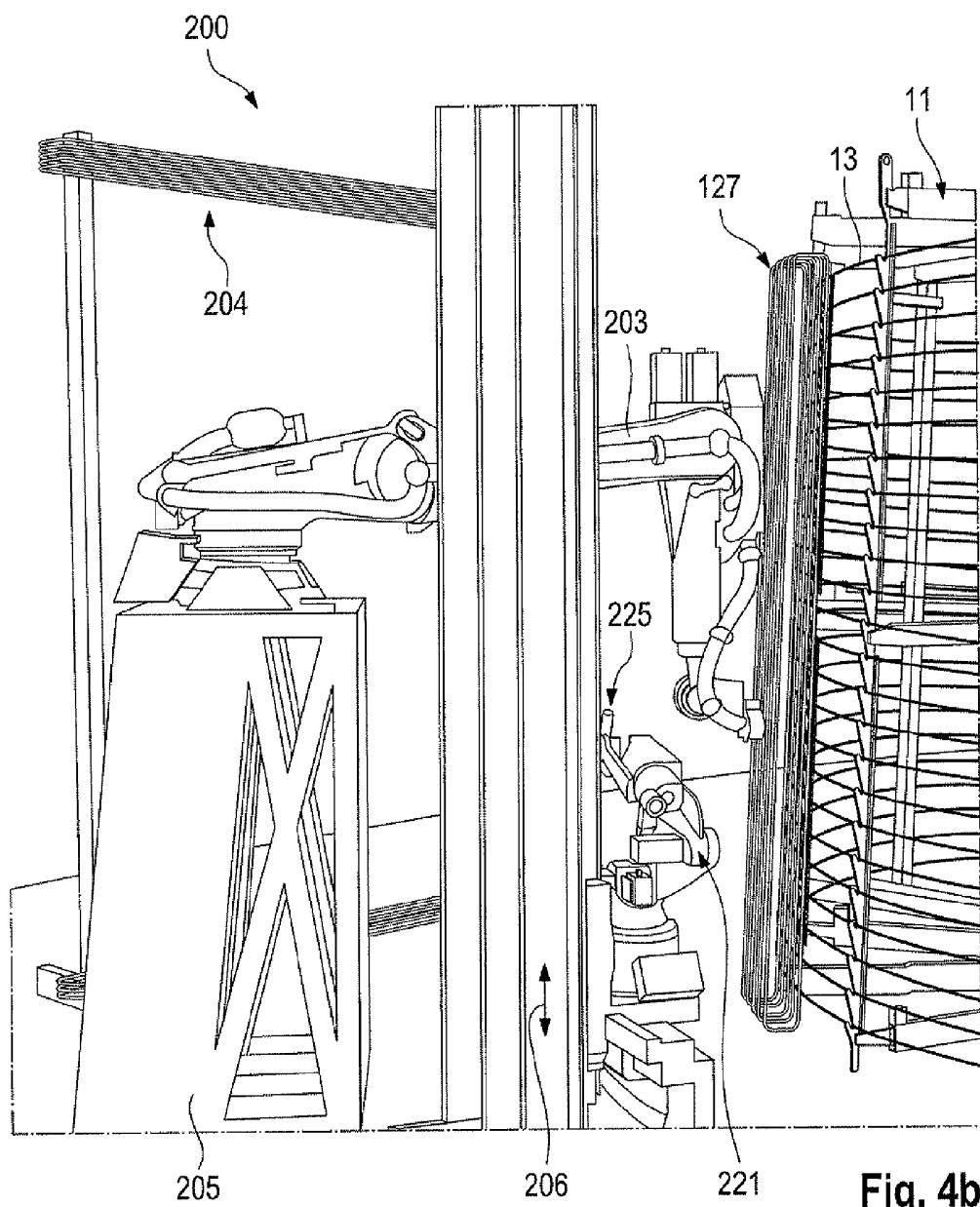


Fig. 3c

Fig. 4a





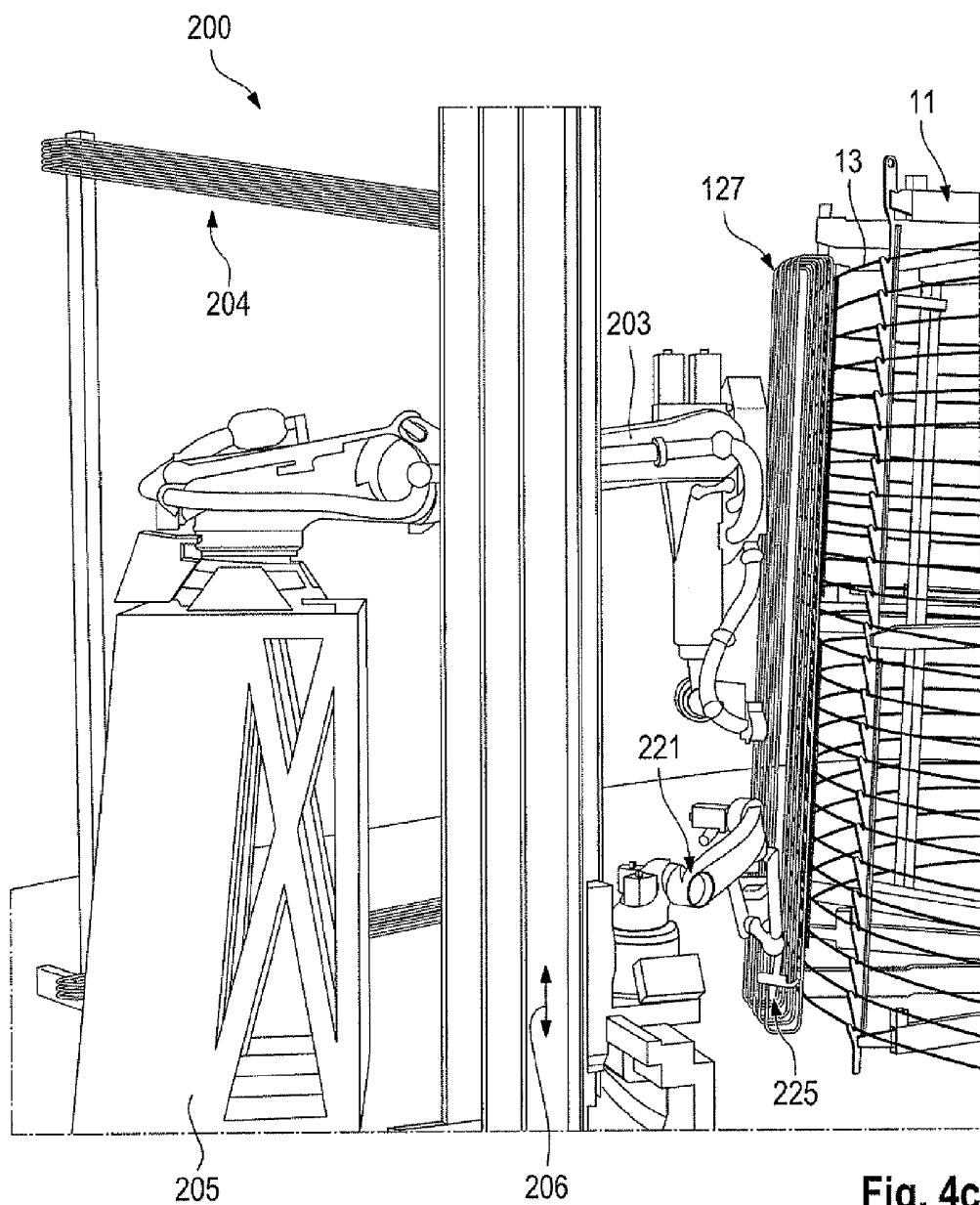


Fig. 4c

Fig. 5a

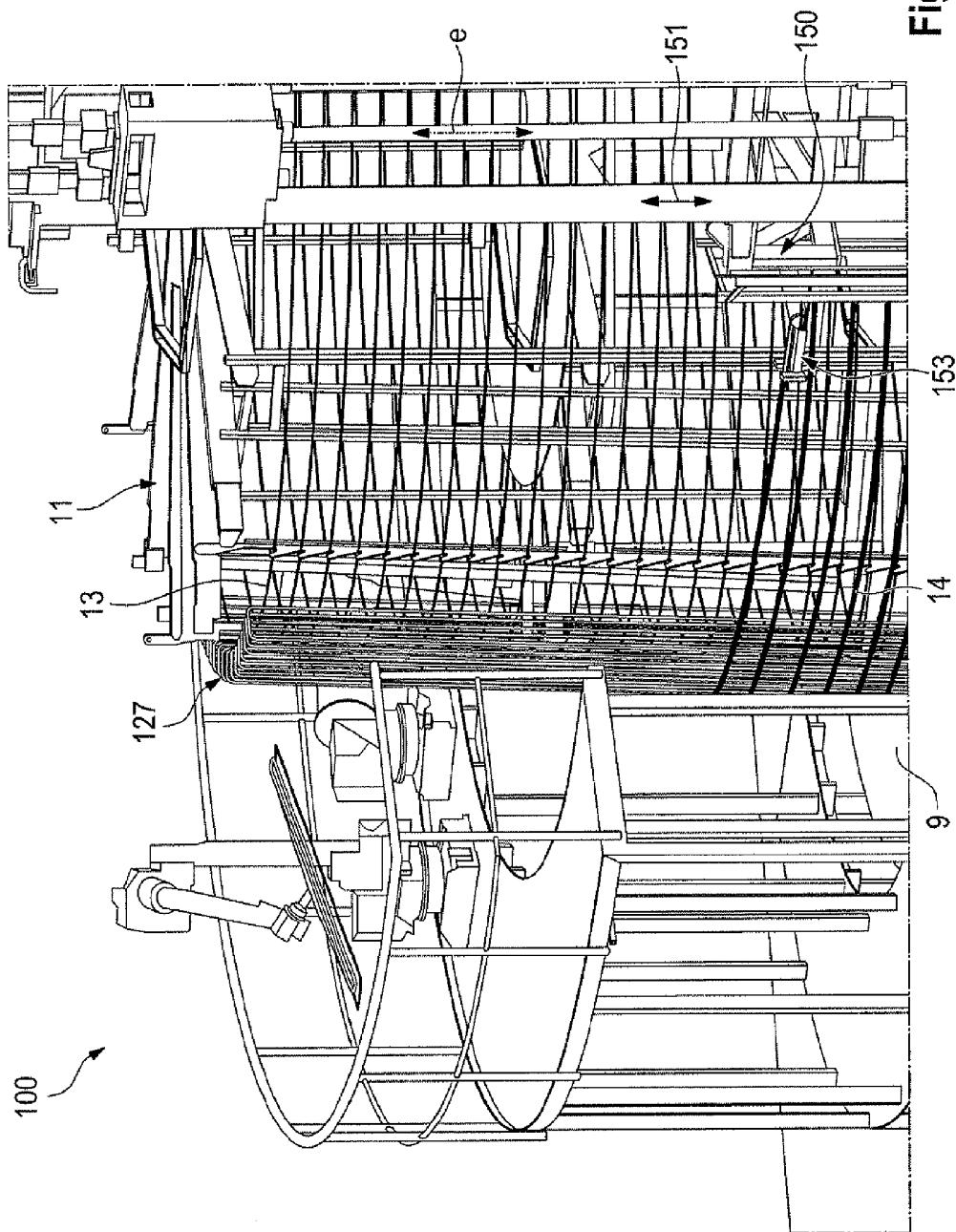
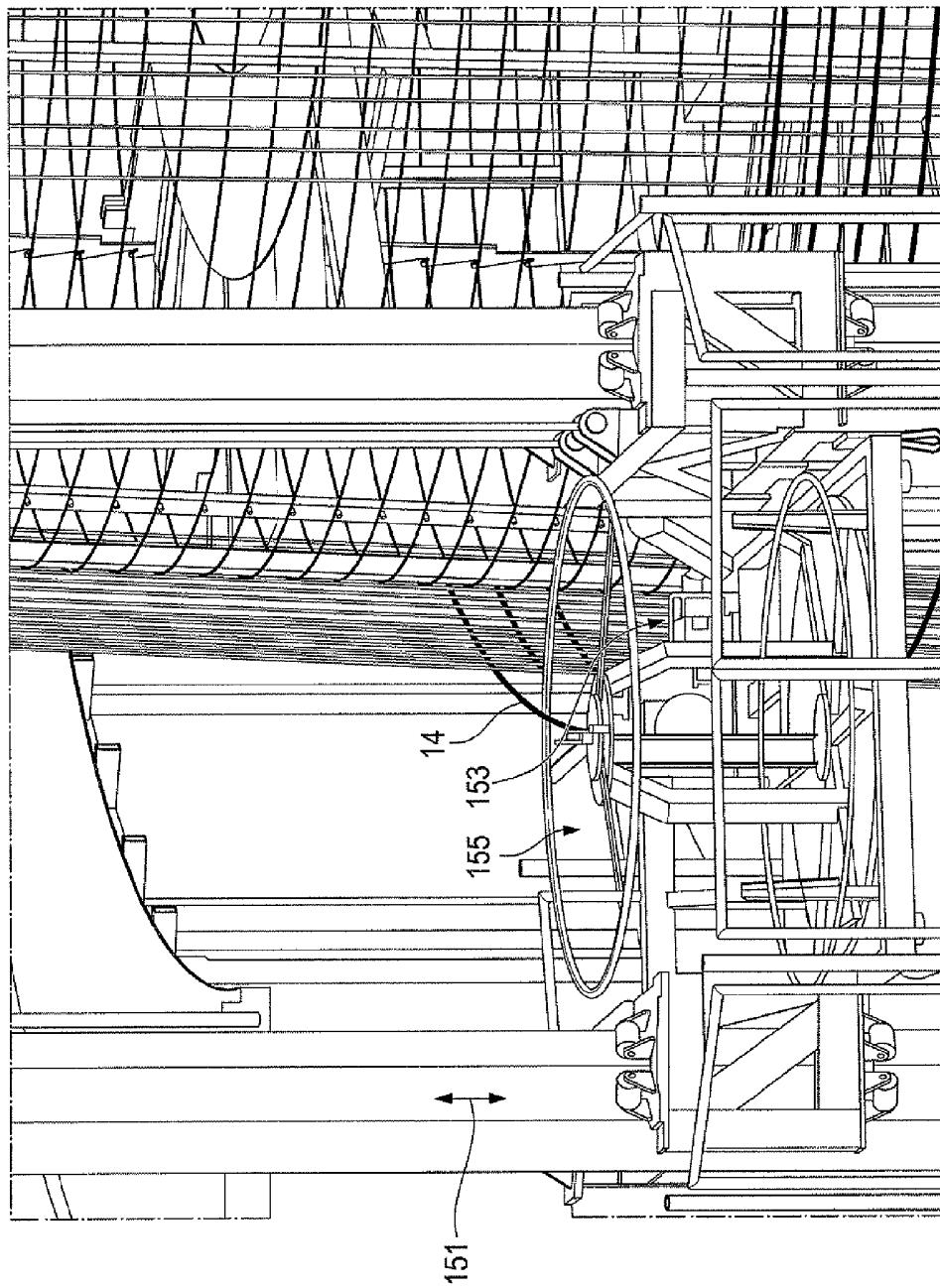


Fig. 5b



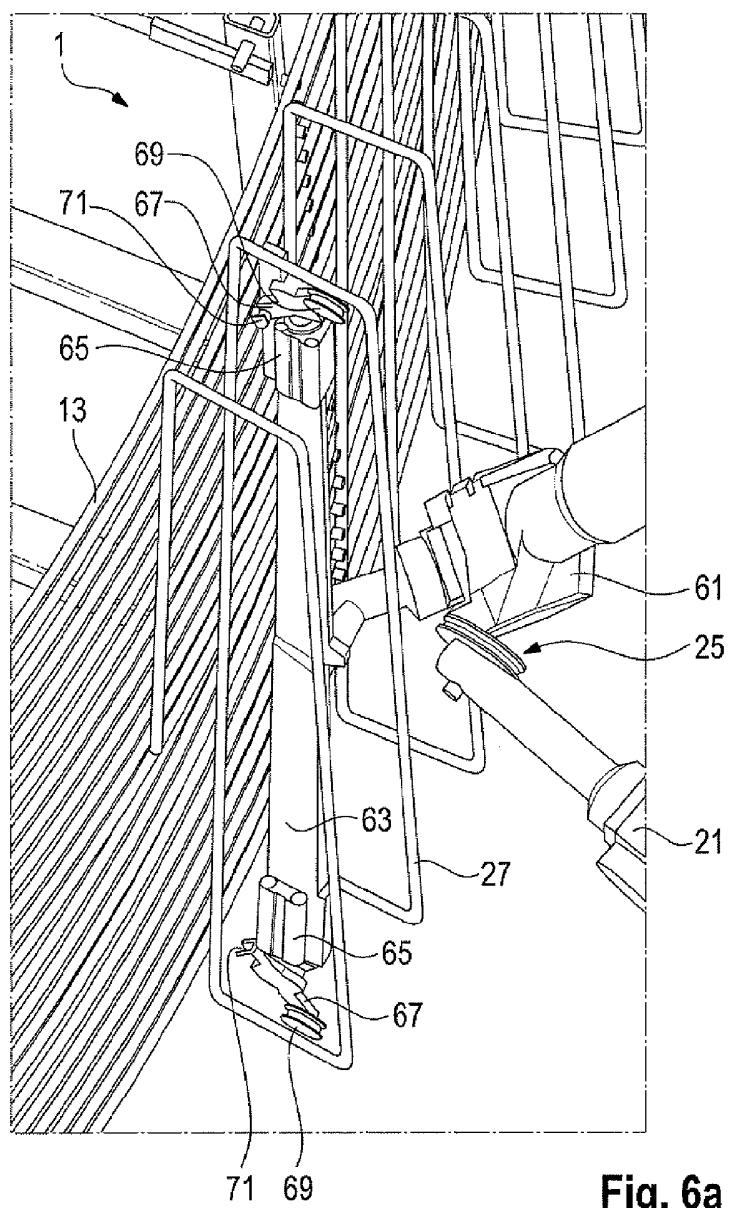


Fig. 6a

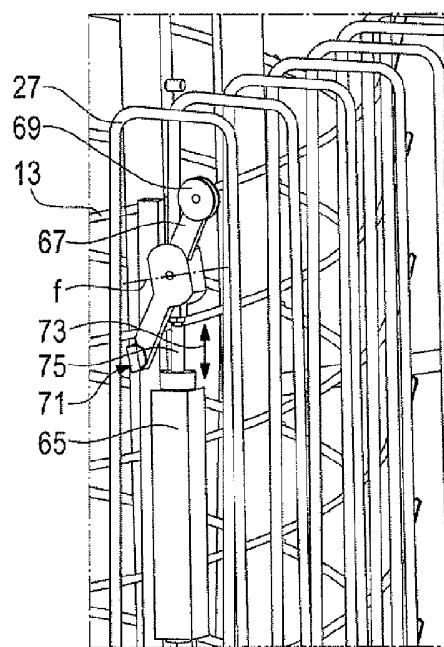


Fig. 6b

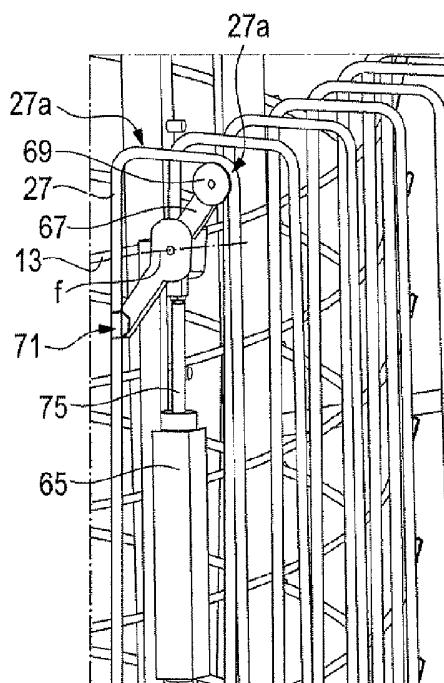


Fig. 6c