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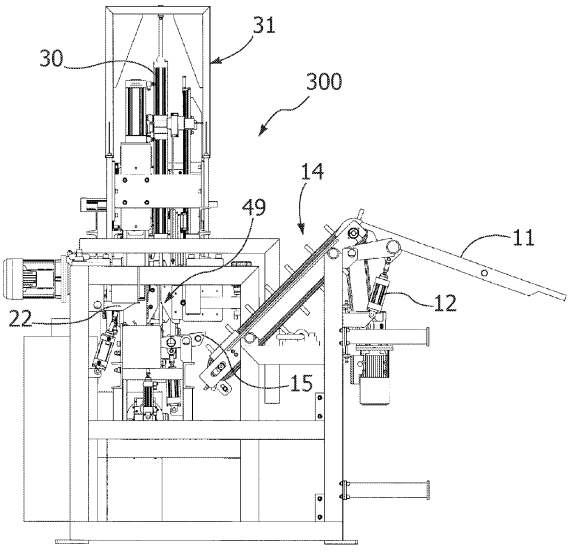
(54) Plant for bending metal bars with automatic loading of the bars, and loading method used in said plant

(57) A plant for bending metal bars, in particular bars designed for reinforcing concrete, of the type comprising:
- at least one bending unit (2) defining a bending plane and a space (8) for receiving a number of bars to be bent set parallel to one another and on top of one another in a plane orthogonal to the bending plane; and
- means for transferring the bars from a magazine of bars, where the bars are set in a bundle right inside said receiving space on said at least one bending unit. The transfer means are designed to pick up a predetermined number of bars from the magazine (M) and feed them one after another into said receiving space (8), keeping them separate and at a distance apart from one another at least in a final step of their being conveyed into the receiving space so as to cause them to reach the receiving space in times that are close to one another but distinct.

FIG. 6



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Description

[0001] The present invention relates to plants for bending metal bars, in particular bars designed for reinforcing concrete, of the type comprising:

- at least one bending unit defining a bending plane and a space for receiving a number of bars to be bent set parallel to one another and on top of one another in a plane orthogonal to the bending plane; and
- means for transferring the bars from a magazine of bars, where the bars are set in a bundle right inside said receiving space on said at least one bending unit.

[0002] A device for transferring metal bars of the type specified above is, for example, described in the patent No. EP-B-1 351 915 filed in the made of the present applicant. Systems of automatic loading of metal bars on machines designed for executing operations of various types on said bars are known from a wide range of documents, such as for example DE-AS-1 101 336, IT 1 206 893, EP-A-1 356 875, EP-A-1 356 876, EP-A-1 980 341, EP-A-2 172 287.

[0003] The object of the present invention is to provide automatic loading of a predetermined number of metal bars onto one or more bending units of the type referred to at the start, guaranteeing that said operation is performed in a reliable, correct, and orderly way.

[0004] With a view to achieving said purpose, the subject of the invention is a plant of the type referred to at the start, characterized in that the aforesaid transfer means are designed to pick up a predetermined number of bars from the magazine and to feed them one after another into said receiving space, keeping them separate and at a distance apart from one another at least in a final step of their being conveyed into the receiving space so as to cause them to reach the receiving space in times that are close to one another but distinct.

[0005] In a preferred embodiment, the plant comprises an intermediate workstation for receiving the bars, set at the side of said at least one bending unit and pre-arranged for receiving the bars picked up from the magazine, said plant comprising means for feeding the bars in succession, one at a time, from said intermediate workstation to said receiving space on said at least one bending unit, displacing the bars in a direction transverse to their longitudinal direction.

[0006] In various embodiments, the transfer means further comprise means for drawing longitudinally the bars picked up from the magazine so as to separate them completely from the bundle in the magazine and deposit them on said intermediate receiving workstation.

[0007] In various embodiments, the means for feeding the bars to said receiving space comprise a sliding plane, via which the bars are made to roll by gravity until they reach the receiving space, a compartment feeder being provided for bringing said bars onto said sliding plane.

[0008] In various embodiments, the transfer means further comprise:

- means for picking up one or more bars from the magazine, gripping the bars by a portion thereof and taking the portions gripped as far as a first raised position;
- means for displacing in succession, one at a time, the portions of the bars picked up from said first raised position to a second raised position, shifted with respect to the first raised position in a direction transverse to the longitudinal direction of the bars, and releasing said portions, as they reach said second raised position, to the means for drawing the bars longitudinally.

[0009] The subject of the invention is also a method for automatic loading of the bars implemented in the plant according to the invention.

[0010] The claims form an integral part of the technical teaching provided herein in relation to the invention.

[0011] Further characteristics and advantages of the invention will emerge from the ensuing description with reference to the annexed drawings, which are provided purely by way of non-limiting example and in which:

Figure 1A is a schematic plan view of a preferred embodiment of the plant according to the invention;
Figures 1B, 1C are schematic plan views that show the structural arrangement of the two bending units forming part of the plant, according to a simplified representation;
Figure 1D is a cross-sectional view of one of the two bending machines, also according to a simplified representation;
Figure 2 is a cross-sectional view of a part of the plant designed for feeding the bars to the bending units;
Figure 3 is a view at an enlarged scale of a detail of Figure 2;
Figure 4 is a perspective view of the part of the plant corresponding to Figure 3;
Figure 5 is a perspective view of a channel for receiving the bars, forming part of the structure of Figure 4;
Figure 6 is an overall side view of the transfer means of the bars of a particularly preferred embodiment;
Figure 7 is a perspective view from beneath of the device for picking up and feeding the bars provided at one end of the plant;
Figure 8 is a perspective view of the magnet pick-up assembly, forming part of the device of Figure 7;
Figure 9 is a perspective view of the assembly for transferring the bars by gripper means, forming part of the device of Figure 7;
Figure 10 is a perspective view of the roller feed assembly, forming part of the device of Figure 7; and

Figures 11A-11F are perspective views that show in succession the various operating steps of the pick-up and feed device Figure 7.

[0012] In Figure 1A, the reference number 1 designates as a whole a plant designed to pick up a predetermined number of metal bars automatically from a magazine M and feed them in the operative position onto two bending units 2. The magazine M is constituted by any structure, whether stationary or mobile on wheels, in which a plurality of bars B are set in a bundle. The structure of the magazine M is not described or illustrated herein in order to simplify the drawings, also in view of the fact that, as has been said, it can be obtained in any known way. With reference to Figure 1A, in the case illustrated the bars in the magazine M are set extended in the direction indicated by the arrows A, on the right of the drawing, in such a way that the end portions of the bars in the magazine M are set underneath a pick-up and feed device 300 provided at one end of the plant 1.

[0013] For greater clarity, Figures 1B and 1C show schematically the structure and operation of the two bending units 2, it remaining understood that each of said units can be obtained in any known way. With reference to the example illustrated, each bending unit 2 (see also Figure 1D) comprises a supporting structure 3, rotatably mounted on which is a bending disk 4 having a central spindle 5 and bearing an eccentric pin 6 for bending a portion of one or more bars B around the central spindle 5. In the specific example illustrated, the axis 4A (Figure 1D) of the bending disk 4 is inclined with respect to the vertical direction. However, it would be equally possible to envisage that said axis is oriented vertically or horizontally, as is also well known in the art. With reference once again to Figure 1B, during bending of one or more bars B the portion of the bar or bars adjacent to the part that undergoes bending comes to rest against a contrast element 7, carried by the structure 3 of the machine, which is illustrated in a purely schematic way in the figures referred to above.

[0014] As is evident from Figure 1D, the two bending units 2 define a space 8 for receiving the bars to be bent, in which a number of bars can be received set on top of one another in a plane orthogonal to the plane of bending of the bars. Once again with reference to Figure 1B, in the case of the example illustrated, the two bending units 2 are mobile on rails 9 in the direction A parallel to the longitudinal direction of lie of the bars B. Alternatively, as is already known in the art, it is, for example, also possible to envisage just one bending unit, mobile in the direction A, and a bending unit set fixed in said direction. Typically, once again according to a technique in itself known, provided within the casing 3 of each bending unit are motor means designed to govern the movement of the bending units along the rails 9. In any case, the motor means could also be situated on the outside of the bending units, as is well known from the prior art. Furthermore, the plant is provided with an electronic control system that governs, according to a pre-set program, the successive movements of the bending units 2 and of the corresponding bending disks 4 to obtain the various bends of a bar or of a set of bars simultaneously subjected to bending, with a view to obtaining any predetermined shape.

[0015] The bending units 2 can be of the type illustrated in Figures 1B, 1C, 1D, with a spindle 5, around which the bars are bent, and with the contrast element 7, or else of the type with a spindle having a diametral split, which also defines the space for receiving the bars. In this case, one of the portions will possibly function also as a contrast element. Figure 1B shows the bar, or bars, positioned on the bending units before execution of a bending operation, whilst Figure 1C shows the two bending units after the bending disks 4 have been turned simultaneously through 90° to carry out two 90° bends at the ends of the bar or bars B.

[0016] Figure 2 shows at an enlarged scale and in side view an embodiment of the stationary structure 30 (see also Figure 1A), on which the two bending units 2 move, defining an inclined plane P coinciding with the plane of bending of the bars defined by the two bending units. Also visible in said figure is one of the two contrast elements 7 associated to one of the two bending units. The structure 30 bearing the two bending units 2 is set alongside a further stationary bench 10 bearing the unit for feeding the bars to the receiving space 8 defined by the two bending units. For this purpose, the stationary structure 10 supports in an articulated way a longitudinal distribution of transverse arms 11 (see also Figure 1A), defining an inclined plane Q, via which the bars B are made to roll by gravity as far as the receiving space 8 defined by the bending units. As has already been mentioned above, the fundamental characteristic of the plant according to the invention lies in the fact that it is able to pick up from the magazine M a predetermined number of bars and to feed said bars one after another into the receiving space 8 of the bending units, keeping them separate and set at a distance from one another in such a way as to cause them to reach the receiving space in times that are close to one another but distinct. To illustrate said characteristic, Figure 2 shows four bars B whilst they are rolling towards the receiving space 8 of the bending unit (not visible in Figure 2) in positions appropriately separated and set at a distance apart from one another.

[0017] The angle of inclination of the transverse arms 11 can be controlled by means of a fluid cylinder 12. In particular, it is possible to envisage a raised condition of the arms 11 in order to prevent any kind of interference between these and the bars that are undergoing bending in the bending units.

[0018] In the case of the embodiment illustrated herein, the bars B are fed to the plane Q by means of a longitudinal distribution of chain conveyors 14 (see also Figure 1A) each provided with a number of projecting elements 14a that define separate compartments 14b (see also Figure 3). According to one embodiment, the compartments 14b of the feed device defined by the chain con-

veyors 14 are each fed with a single bar (see Figure 2) by means of a longitudinal distribution of oscillating arms 15, which are mounted articulated in 16 to the structure 10 and driven by means of fluid cylinders 17 (see Figure 3). Operation of the actuators 17 causes raising of the arms 15 from the position illustrated in Figure 3 to a raised position in such a way that they pick up a bar B that each time is located in a receiving channel 18 (Figure 3) and cause it to roll into a respective compartment 14b of the feed device constituted by the chain conveyors 14.

[0019] The receiving channel 18 constitutes an intermediate workstation designed to receive the bars picked up and from which said bars are then transferred to the feed assembly, designed for feeding the bars in succession, one at a time, to the bending units. In various embodiments, said channel could be defined by trains of rollers, or similar means, designed to bring the bars into a receiving position, from which they can be transferred to the aforesaid feed assembly.

[0020] Figure 4 shows a perspective view of the assembly of Figures 2 and 3, whilst Figure 5 shows a perspective view of the detail of the receiving channel 18, the walls of which are interrupted by grooves for the passage of the arms 15.

[0021] According to one embodiment, as mentioned, the bars picked up from the magazine reach separately, one at a time, the receiving channel 18, as will be described in detail in what follows. When a bar B reaches the receiving channel 18 it is set so as to be correctly positioned with respect to the bending units 2. Since bars of different length are envisaged, each bar, when it reaches the channel 18, is displaced longitudinally until the correct position is reached. For this purpose, provided along the bottom of the channel 18 are openings, slidably mounted in which are plates 19 on which the bars abut, governed by fluid cylinders 20 (see Figure 3). Figure 5 shows the spaces provided in the bottom of the channel 18 within which the plates 19 can be displaced. Advance of the bars along the bottom of the channel 18 is obtained by means of motor-driven rollers. It should be noted that abutment of the bars is optional; for example, in the cases where one of the bending units is fixed, it is not necessary to provide any abutment.

[0022] The bars B reach the channel 18 one at a time and separately, coming from a top channel 21 (Figure 3), the bottom of which is defined by a plane 22 articulated about a longitudinal axis 23, which be lowered by means of a fluid cylinder 24 to bring about dropping of the bar that each time is located in the channel 21 into the receiving channel 18.

[0023] Visible as a whole in Figures 6, 7 is the loading device 300, designed for automatically picking up a predetermined number of bars from the magazine M and feeding them in succession, one after another, separately, to the channel 21 that may be seen in Figure 3.

[0024] The device 300 has a supporting frame 25, which is in turn supported on a structure 26 (Figures 4, 6 and 7) set at one end of the stationary structure 10.

[0025] Figures 8, 9 and 10 show separately three assemblies forming part of the device 300.

[0026] With reference to Figure 8, the reference number 26 designates as a whole an assembly for picking up the bars by means of a magnet, comprising a permanent magnet 27 (or else an electromagnet) supported in an oscillating way about a horizontal axis beneath a supporting block (not visible in the drawing), which is in turn guided in a horizontally sliding way within a supporting element 28. This enables the magnet 27, when it picks up a portion of bar B and lifts it (see Figures 11A and 11B), to tilt according to the inclination assumed by one end portion of the bar and at the same time recede with respect to the block 28 (Figure 11B) as a result of the resistance opposed by the bar B. The block 28 is set at the end of a stem 29 (see Figure 11A) of a fluid actuator 30, the top end of which is anchored to the cross member of a portal structure 31 secured to the frame of the device.

[0027] Figure 9 illustrates in perspective view an assembly for moving the bars B, comprising a gripping device 32 governed electrically and carried by a slide 33 mounted so that it slides vertically on guides 34. The vertical movement of the slide 33 is driven by a motor 35 by means of an external-screw/internal-screw transmission. The guides 34 and the motor 35 are carried by a structure 36, which is in turn mounted like a slide in a horizontal direction transverse to the longitudinal direction of the bars, on guides 37 carried by a plate 38 secured to the stationary structure of the device. The horizontal movement of the slide 36 on the guides 37 is governed by a fluid actuator 39.

[0028] Figure 10 is a perspective view of an assembly for longitudinal feeding of the bars, which uses a roller feed device. Said assembly, designated as a whole by the reference number 40, comprises a stationary supporting structure 41, mounted on the bottom of which are motor-driven rotating rollers 42, driven via a chain transmission 43 by an electric motor 54 (see Figure 11A). The bars are designed for being received one at a time on the bottom motor-driven rollers 42, and being contained in said disposition between the sides 44 of a channel 45, the bottom wall of which 46 is interrupted to enable the bottom rollers 42 to project above it. The bars that each time are located in the channel 45 will then come to be pressed against the bottom motor-driven rollers 42 by three top rollers 46 supported in a freely rotating way on two slides 47 slidably mounted vertically on the stationary structure 41 and controlled by fluid actuators 48.

[0029] Once again with reference to the magnet pick-up device 26, this is obtained, in its general characteristics, according to the teachings of the European patent No. EP-B-1 980 341 filed in the name of the present applicant. In particular, it has a selector element 49 (see Figure 11A) defining a restricted passage 50, preceded by a V-shaped lead-in mouth 51, through which the bars raised by the magnet 27 are to pass. According to what has already been illustrated in the patent mentioned above, the restricted passage 50 forces the bars that are

picked up by the magnet to set themselves on top of one another in a vertical plane in such a way that the magnet pick-up device is able to bring only one bar at a time into the raised position selected.

[0030] The plant presented above operates in the way described in what follows.

[0031] With reference to Figure 11A, the magnet 27 of the pick-up assembly 26 is lowered until it comes into engagement with one or more bars B (just one bar is illustrated for reasons of clarity in Figure 11A), which are present in the magazine M (illustrated only schematically in Figure 11A). The magnet 27 is then raised, taking along with it one or more bars B as far as the restricted passage 50. The presence of said passage means that just one bar manages to remain attached to the magnet 27 after this has overstepped the position corresponding to the restricted passage 50. As may be seen in Figure 11B, the single bar B that has remained attached to the magnet 27 (which in the mean time has assumed its retracted and inclined position) reaches a first raised position, which is represented in Figure 11B. When the portion of the bar B that is carried by the magnet reaches the aforesaid first raised position (Figure 11 B), the gripper 32 of the gripper assembly is already in a lowered position, suitable for gripping another portion of the same bar B. The gripper 32 is in particular governed in said lowered position by the electronic control means of the plant, which have instructions for the governed positions of the gripper, which depend upon the diameter and the length of the different types of bars that are being handled. In the example of embodiment illustrated, associated to the gripper are the sensor means for sending a signal to the electronic control unit of the plant whenever it receives a bar in it. In this way, the system is able to count the bars picked up, as these reach the gripper, so as to verify that any chosen number of bars is fed. Of course, however, the means for counting the number of bars picked up could also be altogether different and arranged in other points of the plant. It should be noted that, as soon as the sensor means associated to the gripper detect the presence of a bar, the magnet 27 is deenergized (or else shielded, or, in general, any other intervention is made, such as a mechanical action of thrust, that will enable detachment of the bar) in order to release said bar to the gripper 32.

[0032] As may be seen in Figure 11C, the gripper 32 is then displaced transversely until the bar B is brought over the channel 45 so as to be able to unload it thereon. Figure 11D shows the step in which the gripper 32 has opened and the bar B is dropping into the channel 45 onto the bottom motor-driven rollers 42. At this point, the top rollers 46 are lowered to press the bar B, or rather the portion of bar that has been previously gripped by the magnet 27, onto the bottom motor-driven rollers 42. The rollers 42 and 46 are thus able to feed the end portion of the bar B previously gripped longitudinally forwards, in the direction X as shown in Figure 11F so as to separate the bar B completely from the bundle in the magazine M and feed it on the channel 21 (Figure 3), as has been described above. As may also be seen in Figure 11F, during said step (or even before, for example as soon as the magnet releases the bar to the gripper 32), the magnet 27 returns in the mean time into its lowered position for picking up an end portion of a new bar B from the magazine M. As may be seen, then, the magnet 27 is displaced alternately between its lowered position and its raised position whenever the plant has to operate for feeding a predetermined number of bars to the bending units, said operation carrying in succession one bar at a time as far as the channel 21 from which the bar, as soon as it is received in the channel 21, is dropped into the receiving channel 18. Consequently, also the receiving channel 18 receives the bars in succession, one after another and separately. In this embodiment, whenever a bar reaches the receiving channel 18, the abutment plate 19 corresponding to the length of bar is activated, and the bar is fed longitudinally until one end thereof comes into contact with the abutment plate 19, which thus ensures that the bar is positioned longitudinally along the channel 18 in an adequate way for subsequently undergoing treatment in the bending units 2. As soon as the bar has each time been correctly positioned longitudinally in the receiving channel 18, it is transferred by raising of the arms 15 (Figure 3) into a corresponding compartment 14B of the feed device constituted by the chain conveyors 14.

[0033] Following upon the successive repetition of said cycle of operations, the feed device 14 is then fed with a plurality of bars B, each compartment 14 B of the device receiving a single bar, as illustrated in Figure 2.

[0034] Consequently, the bars B are translated, in a direction orthogonal to their longitudinal direction until they reach the plane of fall Q defined by the arms 11, onto which they roll by gravity in the direction of the receiving space 8 defined by the two bending units 2 (see Figure 2 and Figure 1D).

[0035] Consequently, the plant according to the invention is able to pick up from the magazine M any given number of bars and to feed them into the receiving space 8 defined by the two bending units keeping them appropriately separate and set at a distance apart in such a way as to cause them to reach the receiving space in times that are close to one another but distinct. In particular, the speed of the chain elevators and the inclination of the sliding arms are chosen in such a way that the bars roll on the arms as far as the receiving space, remaining at a distance apart from one another so as to reach the receiving space in times that are very close to one another but distinct.

[0036] In general, whatever the transfer means adopted, the control means of the plant described herein, which could for example be electronic control means, are designed to control said transfer means in such a way as to pick up a predetermined number of bars from the magazine M and feed them one after another into the receiving space of the bending unit, keeping them separate

and at a distance apart from one another at least in a final step of conveying into the receiving space so as to cause them to reach the receiving space in times that are close to one another but distinct. In particular, the electronic control means are designed to govern the transfer means in such a way that the bars are unloaded into the aforesaid receiving space at an appropriate time interval between one bar and the next. As emerges from the foregoing, said interval is chosen so as to be sufficiently long to prevent any entangling between successive bars, but at the same time as short as possible to enable loading in a short time of big lots of bars.

[0037] Preferably, the electronic control means of the plant described herein are designed to determine the aforesaid interval according to the type of bars to be loaded (for example, according to their diameter, length, and/or mechanical characteristics). The present applicant has in fact found that, when the bars are unloaded into the receiving space of the bending unit, these, bumping against the surfaces of said unit, tend to bounce and oscillate like a cord, and the ease with which they get entangled or bestraddle one another depends precisely upon how marked is their behaviour. Specifically, to a first approximation, the longer and thinner (and hence flexible) the bars, the more they will tend to bestraddle one another, whereas the shorter the bars and the larger their diameter (and hence the stiffer the bars), the more they will, instead, tend to maintain their position. In view of the above, the electronic control means will govern the transfer means so as to envisage longer intervals for unloading in succession, into the receiving space, the more flexible bars, and then shorter intervals for unloading in succession the stiffer bars. Said preferred control mode makes it possible to reduce as much as possible, for every type of bar, the times of loading onto the bending unit, without any entanglement of the bars being loaded.

[0038] Furthermore, control means can be provided for determining the aforesaid interval also according to other variables that are not directly linked to the type of bars but do, however, have some influence on the phenomenon of entangling between the bars, such as for example the mutual position between the bars and the elements of the bending unit upon which the bars come to bear when they are unloaded onto the bending unit (for example, the spindles 5). Also in this case, the shorter the interval the higher the risk of the bars bestraddling one another.

[0039] In any case, the electronic control means can also envisage a single interval for a number of types of bars. In the latter case, from what has been said above, said interval will, for example, be determined according to the most flexible type of bar or the bar that requires the longest time interval to prevent any bestraddling of the bars during loading onto the bending units. Thanks to the aforesaid characteristics, the plant according to the invention guarantees that the operation of loading of the bars on the bending units is executed always in a correct and orderly way, without any risk of bestraddling of the bars or jamming thereof at the mouths of the receiving space on the bending units, as instead occurs in plants according to the known art. In various embodiments, it is moreover possible to provide a cutting unit in any point of the path of transfer of the bars between the magazine containing the bundles of bars and the bending units, for example at an intermediate point of the stretch of longitudinal entrainment of the bars.

[0040] In various embodiments, to displace the bars in a direction transverse to their longitudinal direction or to feed them to the drawing means, or else to bring them to the inclined plane from which the bars roll into the receiving space, the bar-feed assembly can envisage one of the following alternative embodiments:

- at least one rotating roller, set in a direction transverse to the longitudinal direction of the bars, having a helical portion along its outer surface, pre-arranged for engagement with a portion of the bar for displacement of said portion along the axis of said roller;
- a chain conveyor; and
- a gripper conveying system.

[0041] Of course, without prejudice to the principle of the invention, the details of construction and the embodiments may vary widely with respect to what has been described and illustrated herein purely by way of example, without thereby departing from the scope of the present invention.

Claims

1. A plant for bending metal bars, in particular bars designed for reinforcing concrete, of the type comprising:

- at least one bending unit (2) defining a bending plane and a space (8) for receiving a number of bars to be bent set parallel to one another and on top of one another in a plane orthogonal to the bending plane,
- means (26, 32, 40, 22, 15, 14, 11) for transferring the bars from a magazine of bars, where the bars are set in a bundle right inside said receiving space on said at least one bending unit; and
- means for control of said transfer means,

said plant being **characterized in that** said control means are designed to govern said transfer means so as to pick up a predetermined number of bars from the magazine (M) and feed them one after another into said receiving space (8), keeping them separate and at a distance apart from one another at least in a final step of their being conveyed into the receiving space (8) so as to cause them to reach the receiving space in times that are close to one another but distinct.

2. The plant according to Claim 1, **characterized in that** it comprises an intermediate workstation (18) for receiving the bars, set alongside said at least one bending unit (2) and pre-arranged for receiving the bars picked up from the magazine (M), said plant comprising means (14) for feeding the bars in succession, one at a time, from said intermediate workstation (18) to said receiving space on said at least one bending unit, displacing the bars in a direction transverse to their longitudinal direction.

3. The plant according to Claim 2, **characterized in that** said intermediate receiving workstation (18) comprises a receiving channel.

4. The plant according to either Claim 2 or Claim 3, **characterized in that** said transfer means further comprise means (40) for drawing longitudinally the bars picked up from the magazine (M) so as to separate them completely from the bundle in the magazine and deposit them on said intermediate receiving workstation.

5. The plant according to Claim 4, **characterized in that** said transfer means further comprise:

   - means (26) for picking up one or more bars from the magazine, gripping the bars for a portion thereof; and
   - means (32) for displacing the portions of the bars picked up in a direction transverse to the longitudinal direction of the bars, and releasing the portions of a predetermined number of bars in succession, one at a time, to the means for drawing the bars longitudinally.

6. The plant according to Claim 4, **characterized in that** said transfer means further comprise:

   - means (26) for picking up one or more bars from the magazine, gripping the bars for a portion thereof and bringing the gripped portions as far as a first raised position;
   - means (32) for displacing in succession, one at a time, the portions of the bars picked up from said first raised position to a second raised position, shifted with respect to the first raised position in a direction transverse to the longitudinal direction of the bars, and releasing said portions, as they reach said second raised position, to the means for drawing the bars longitudinally.

7. The plant according to any one of Claims 4 to 6, **characterized in that** said means (40) for drawing the bars are designed to send the bars in succession, one at a time, to said intermediate workstation.

8. The plant according to any one of the preceding claims, **characterized in that** it comprises a cutting unit upstream of said at least one bending unit.

9. The plant according to any one of the preceding claims, **characterized in that** said means for feeding the bars to said receiving space comprise a sliding plane (11), via which the bars are made to roll by gravity until they reach the receiving space, a compartment feeder (14) being provided for bringing said bars onto said sliding plane.

10. The plant according to any one of Claims 1 to 8, **characterized in that** said means for feeding the bars to said receiving space comprise a sliding plane (11), via which the bars are made to roll by gravity until they reach the receiving space, at least one rotating roller being provided for bringing said bars onto said sliding plane, said roller being set in a direction transverse to the longitudinal direction of the bars, and having a helical portion along its outer surface, pre-arranged for engagement with a portion of the bars for displacement of said portion along the axis of said roller.

11. The plant according to any one of Claims 1 to 8, **characterized in that** said means for feeding the bars to said receiving space comprise a sliding plane (11), via which the bars are made to roll by gravity until they reach the receiving space, a compartment conveyor (14) being provided for bringing said bars onto said sliding plane.

12. The plant according to any one of Claims 4 to 7, **characterized in that** said means for drawing the bars longitudinally comprise a feed device (40) with opposed rollers, wherein a first set of rollers (46) is designed to press the bars against a second set of rollers (42) to feed the bars themselves, at least one between said first and second sets being motor-driven.

13. The plant according to any one of Claims 5 to 7, **characterized in that** said means for displacing the bars in a direction transverse to the longitudinal direction of the bars comprise a gripping device (32) carried by a slide (36) mobile in a direction transverse to the longitudinal direction of the bars.

14. The plant according to any one of Claims 5 to 7, **characterized in that** said means for displacing the bars in a direction transverse to the longitudinal direction of the bars comprise at least one rotating roller, set in a direction transverse to the longitudinal direction of the bars, and having a helical portion along its outer surface, pre-arranged for engagement with a portion of the bars for displacement of said portion along the axis of said roller.

15. The plant according to any one of Claims 5 to 7, **characterized in that** said means for displacing the bars in a direction transverse to the longitudinal direction of the bars comprise a chain conveyor.

16. The plant according to any one of the preceding claims, **characterized in that** it comprises an assembly (26) for picking up the bars from the bundle of bars in the magazine, comprising a magnet (27) supported in an oscillating way about a horizontal axis and sliding in a horizontal plane.

17. The plant according to any one of the preceding claims, **characterized in that** it comprises counting means for feeding a predetermined number of bars to said at least one bending unit.

18. A method for automatic loading of metal bars, in particular bars designed for reinforcing concrete, in a plant for bending the bars comprising at least one bending unit (2) defining a bending plane and a space (8) for receiving a number of bars (B) to be bent set parallel to one another and on top of one another in a plane orthogonal to the bending plane, wherein the bars are transferred from a magazine (M) of bars, where the bars (B) are set in a bundle right inside said receiving space (8) on said at least one bending unit,
said method being **characterized in that** a predetermined number of bars is picked up from the magazine (M) and said bars are fed one after another into said receiving space (8), keeping them separate and at a distance apart from one another at least in a final step of conveying in the receiving space so as to cause them to reach the receiving space in times that are close to one another but distinct.

19. The method according to Claim 18, **characterized in that** an intermediate workstation (18) is provided for receiving the bars, alongside said at least one bending unit (2), which receives the bars picked up from the magazine (M), and feeds them in succession, one at a time, from said intermediate workstation to said receiving space on said at least one bending unit (2), displacing the bars in a direction transverse to their longitudinal direction.

20. The method according to Claim 19, **characterized in that** the bars picked up from the magazine (M) are drawn longitudinally so as to separate them completely from the bundle in the magazine and deposit them on said intermediate receiving workstation.

21. The method according to any one of Claims 19 and 20, **characterized in that**:

- one or more bars are picked up from the magazine (M) by gripping the bars for a portion thereof; and
- the portions of the bars picked up are displaced, in a direction transverse to the longitudinal direction of the bars, and the portions of a predetermined number of bars are released in succession, one at a time, to means (40) for drawing the bars longitudinally up to said intermediate workstation (18).

22. The method according to any one of Claims 19 and 20, **characterized in that**:

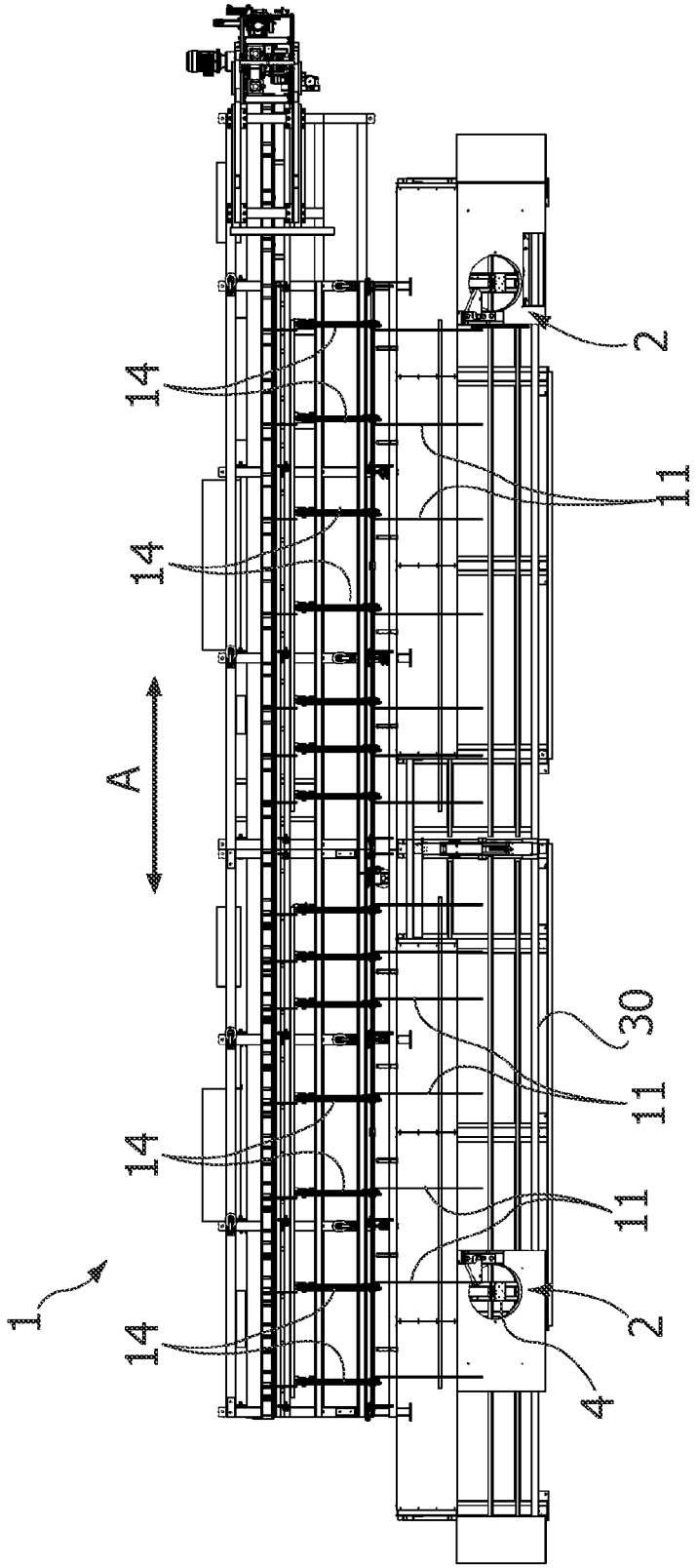
- one or more bars are picked up from the magazine by gripping the bars for a portion thereof and bringing the gripped portions as far as a first raised position,
- the portions of the bars picked up are displaced from said first raised position, one at a time, to a second raised position, shifted with respect to the first raised position in a direction transverse to the longitudinal direction of the bars, and said portions are released, as they reach said second raised position, to means for drawing the bars longitudinally.

23. The method according to any one of Claims 19 to 22, **characterized in that** the bars are made to roll by gravity, along a sliding plane (11), until they reach the receiving space (8), said bars being brought in succession, one at a time, onto said sliding plane.

24. The method according to any one of Claims 18 to 23, **characterized in that** a step of cutting of the bars is envisaged before these are fed to the bending unit.

25. The method according to any one of Claims 18 to 24, **characterized in that** a step of counting of the bars to be fed to the bending unit is envisaged.

FIG. 1A



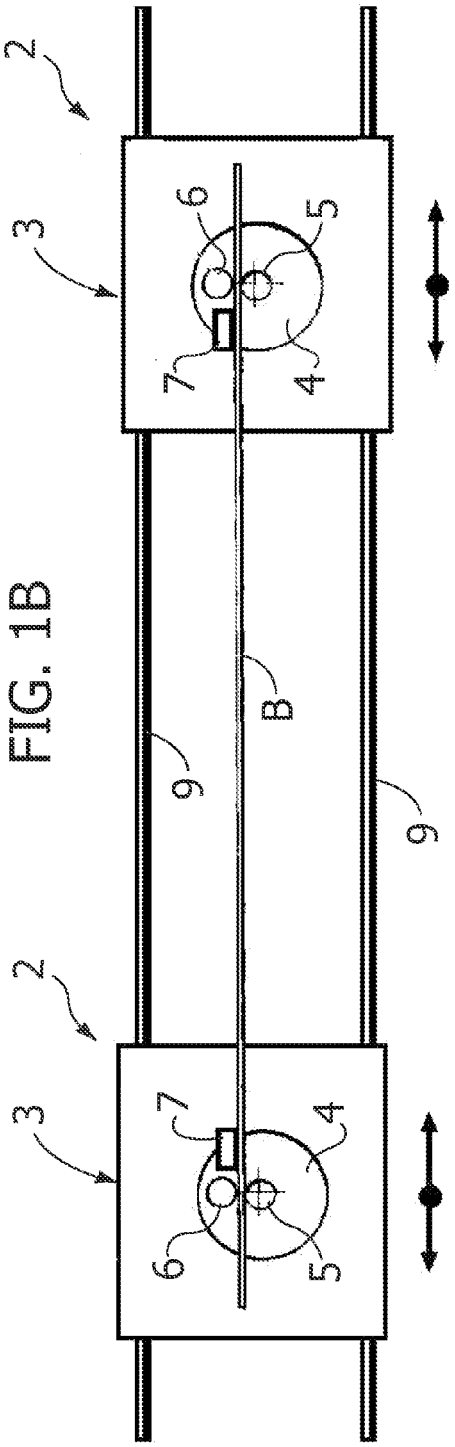


FIG. 1B

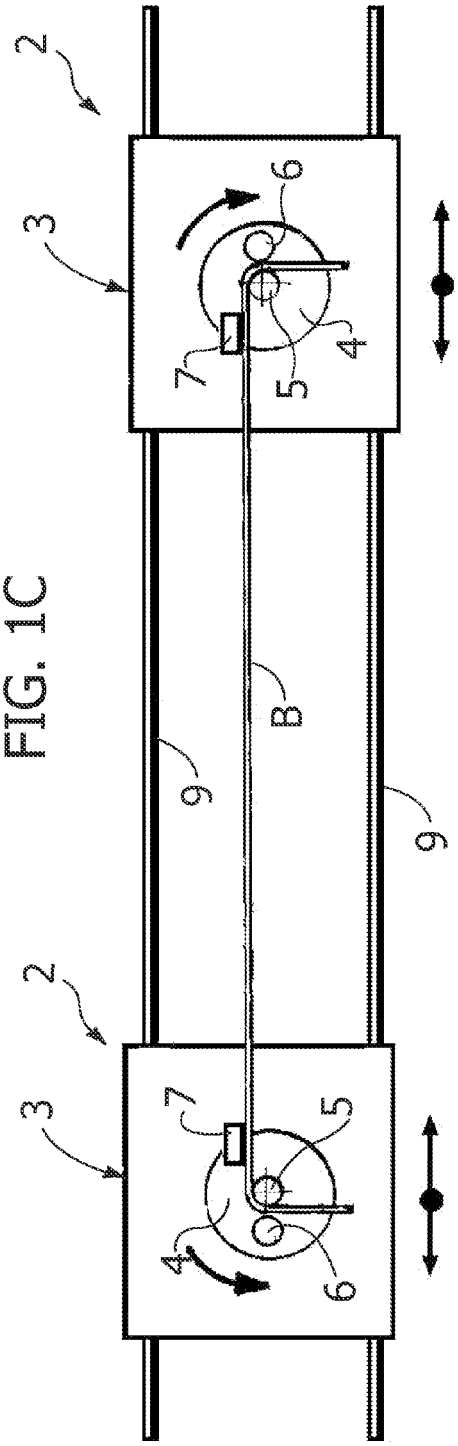


FIG. 1C

FIG. 1D

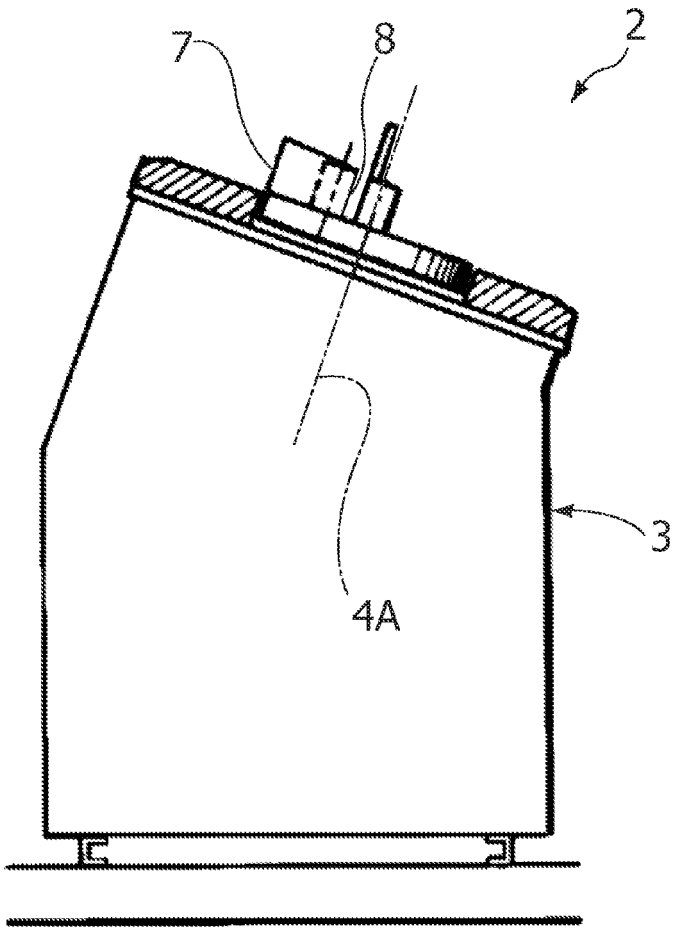


FIG. 2

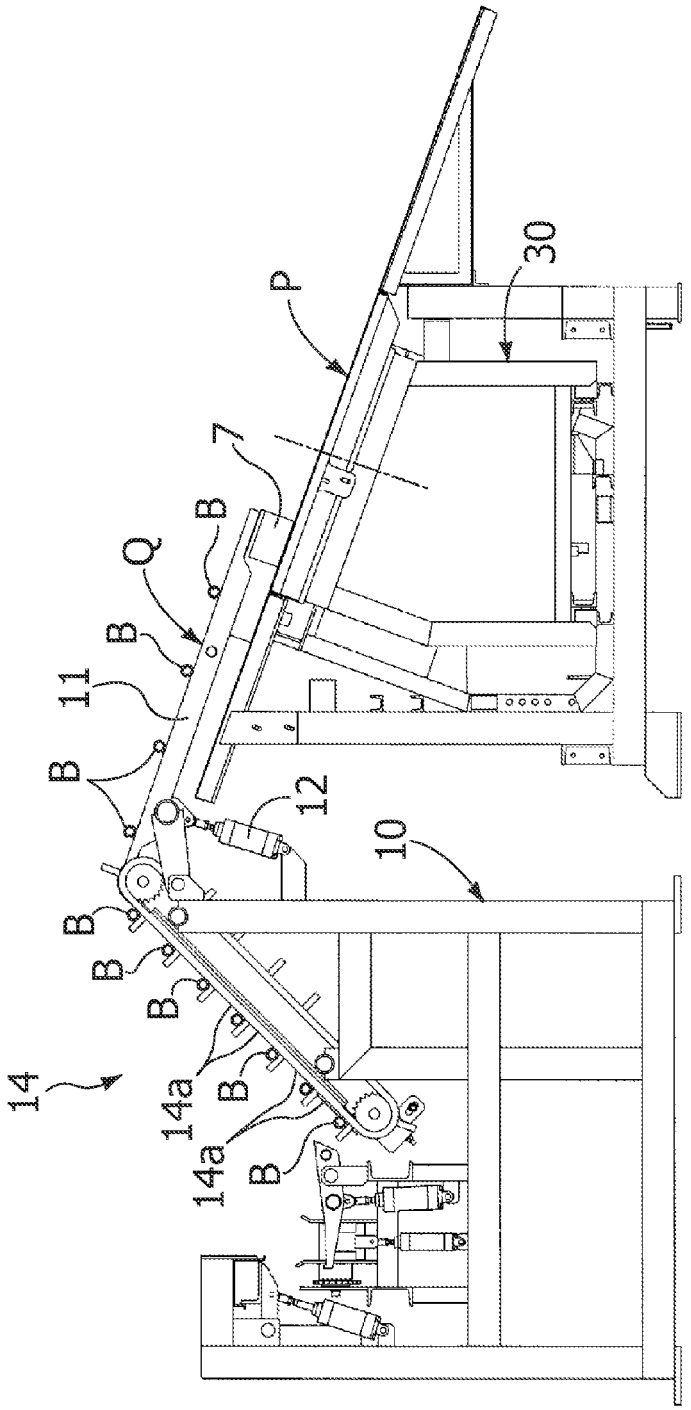


FIG. 3

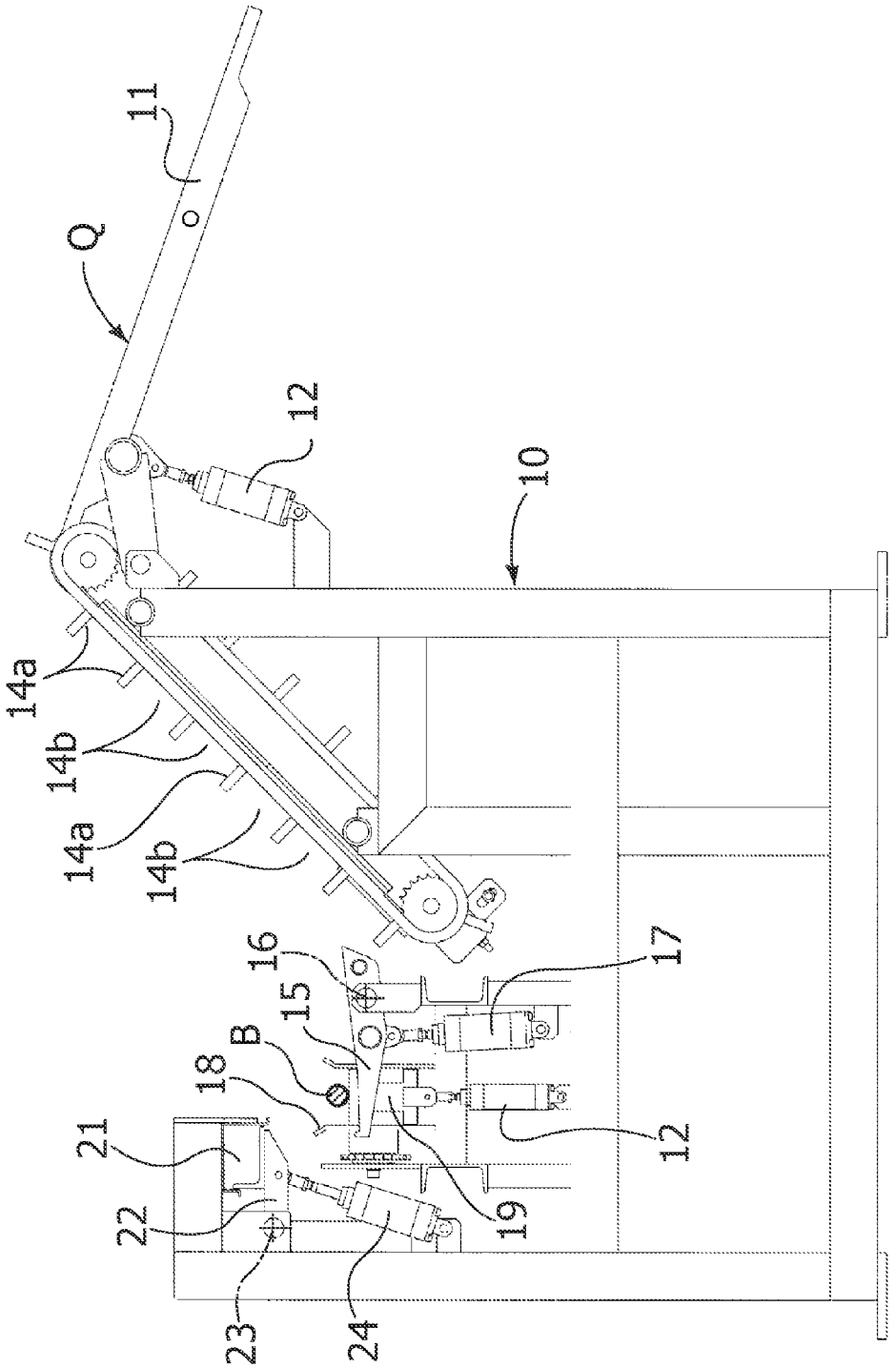


FIG. 4

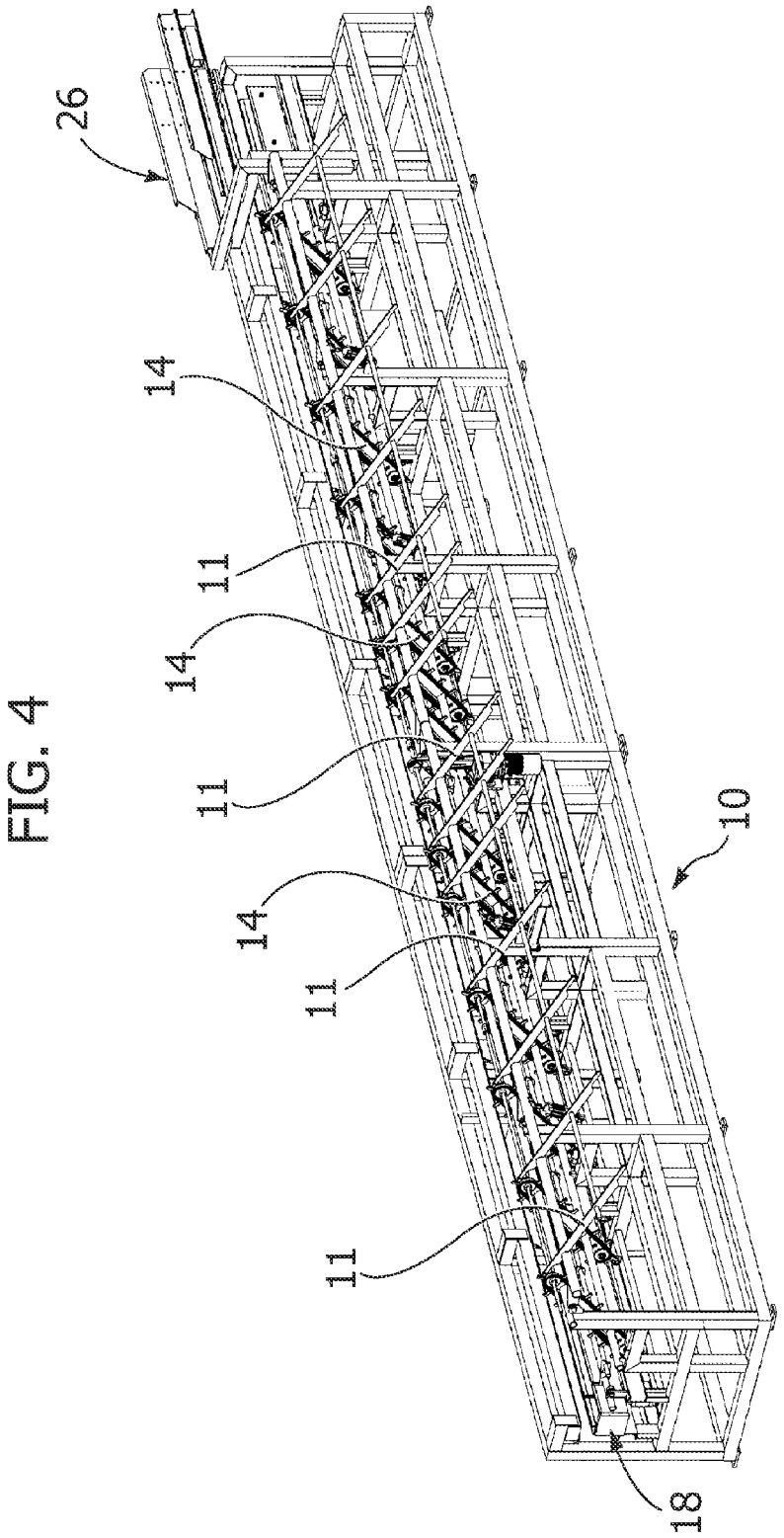


FIG. 5

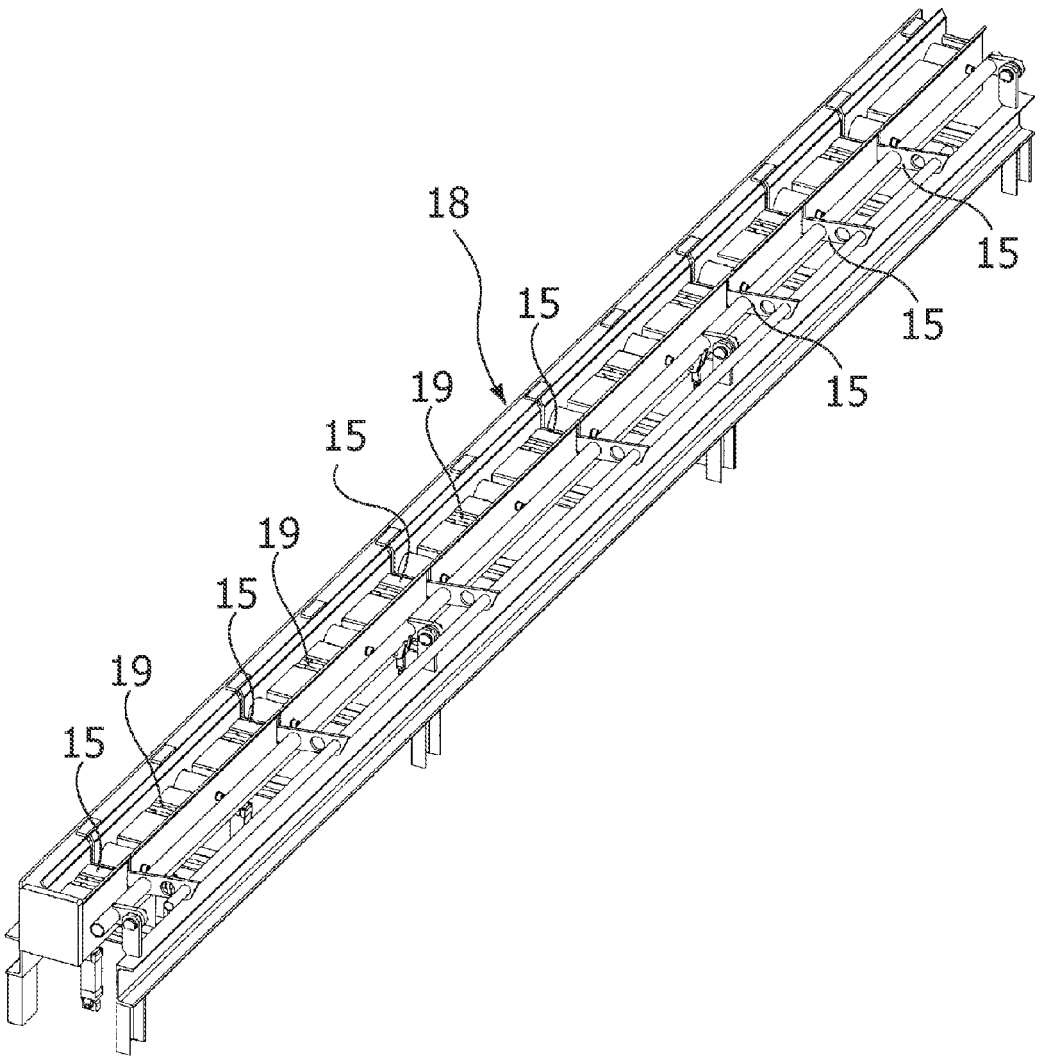


FIG. 6

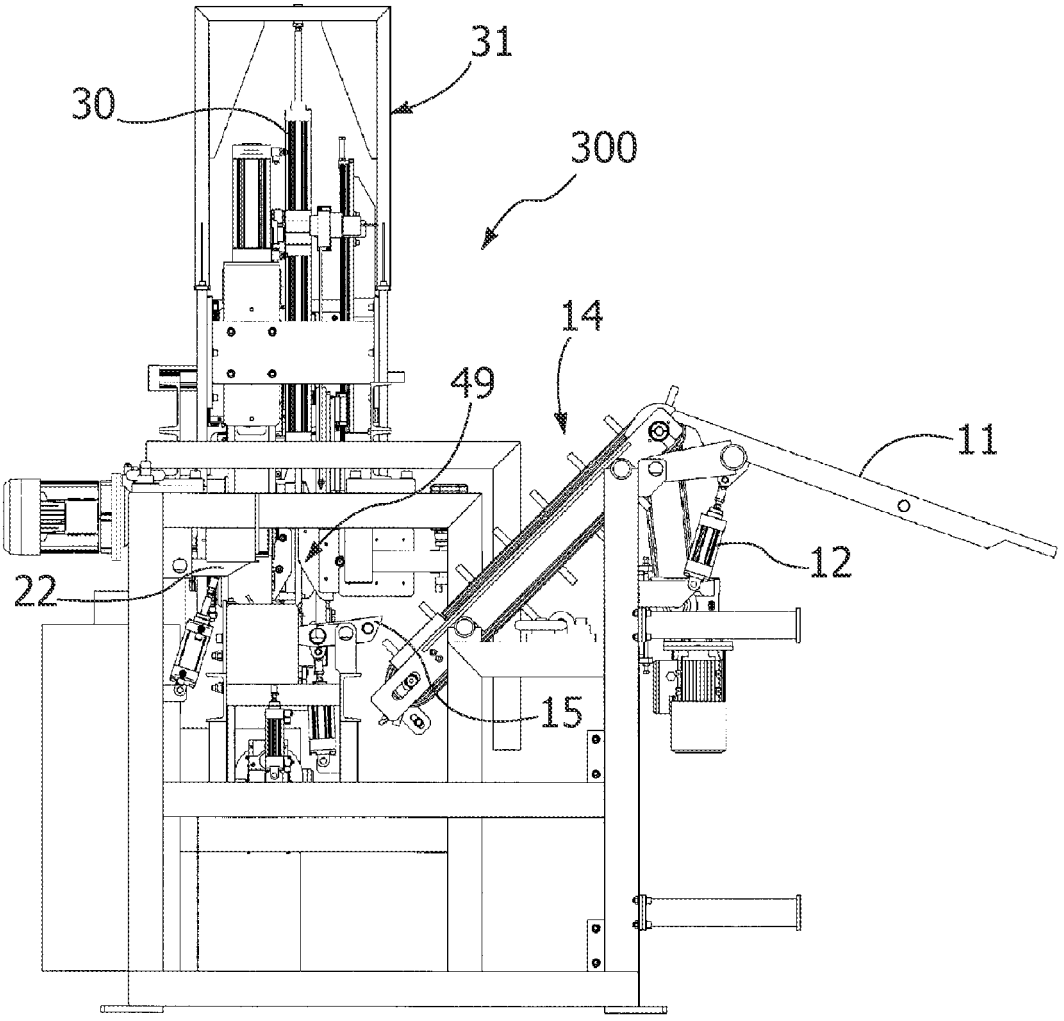


FIG. 7

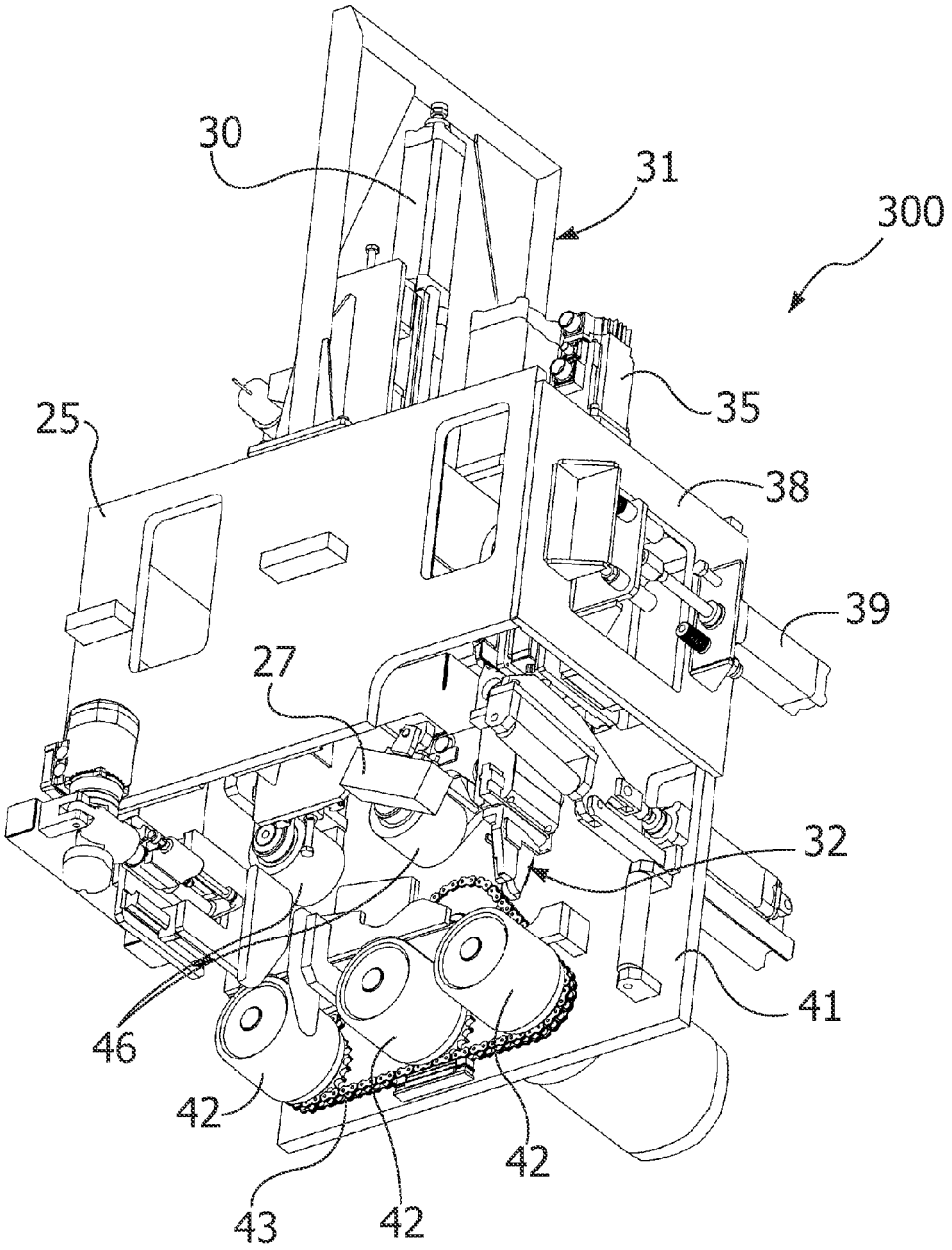


FIG. 8

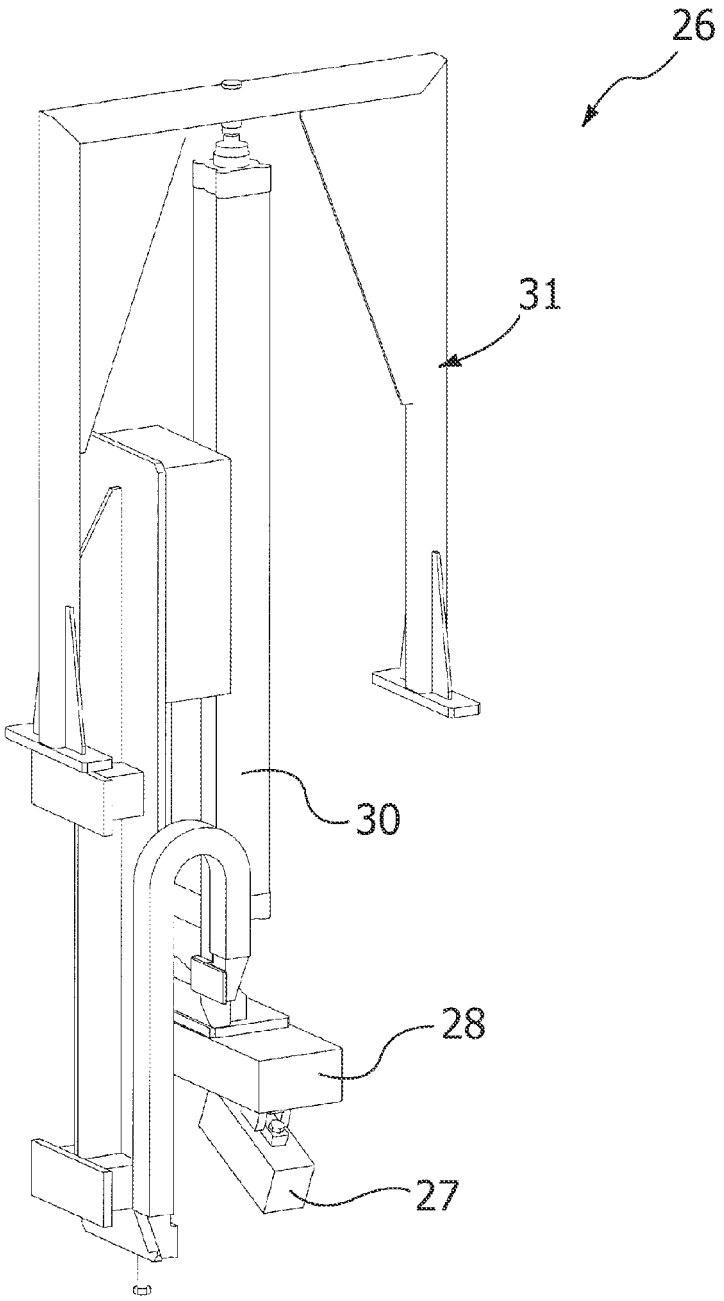


FIG. 9

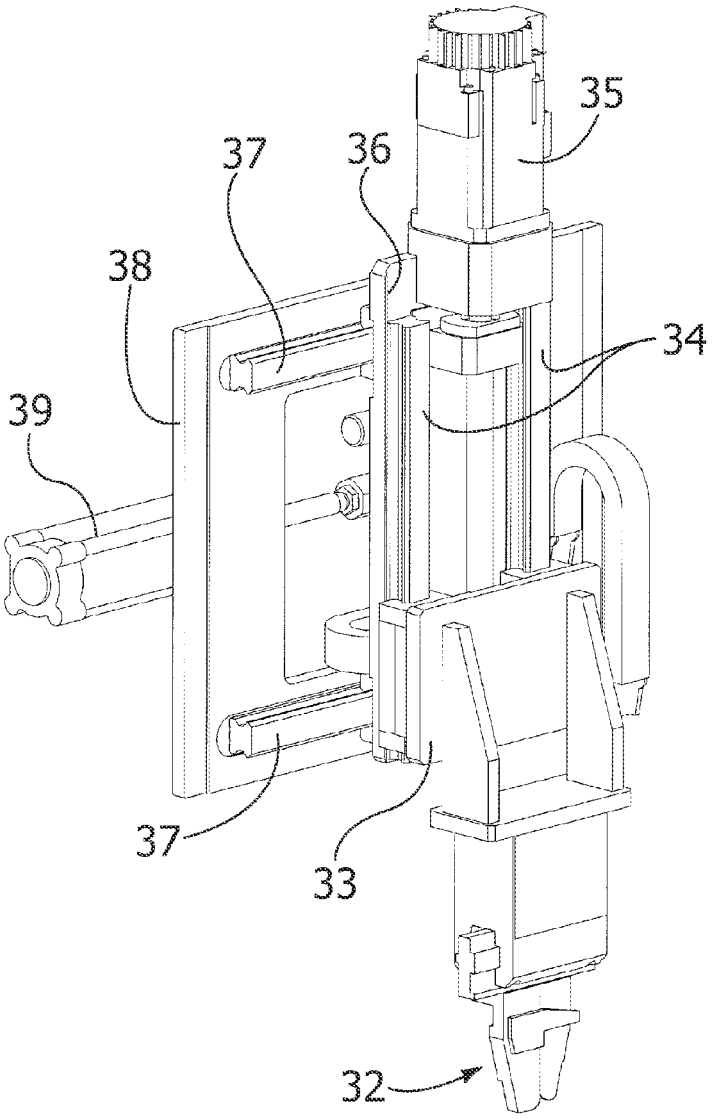


FIG. 10

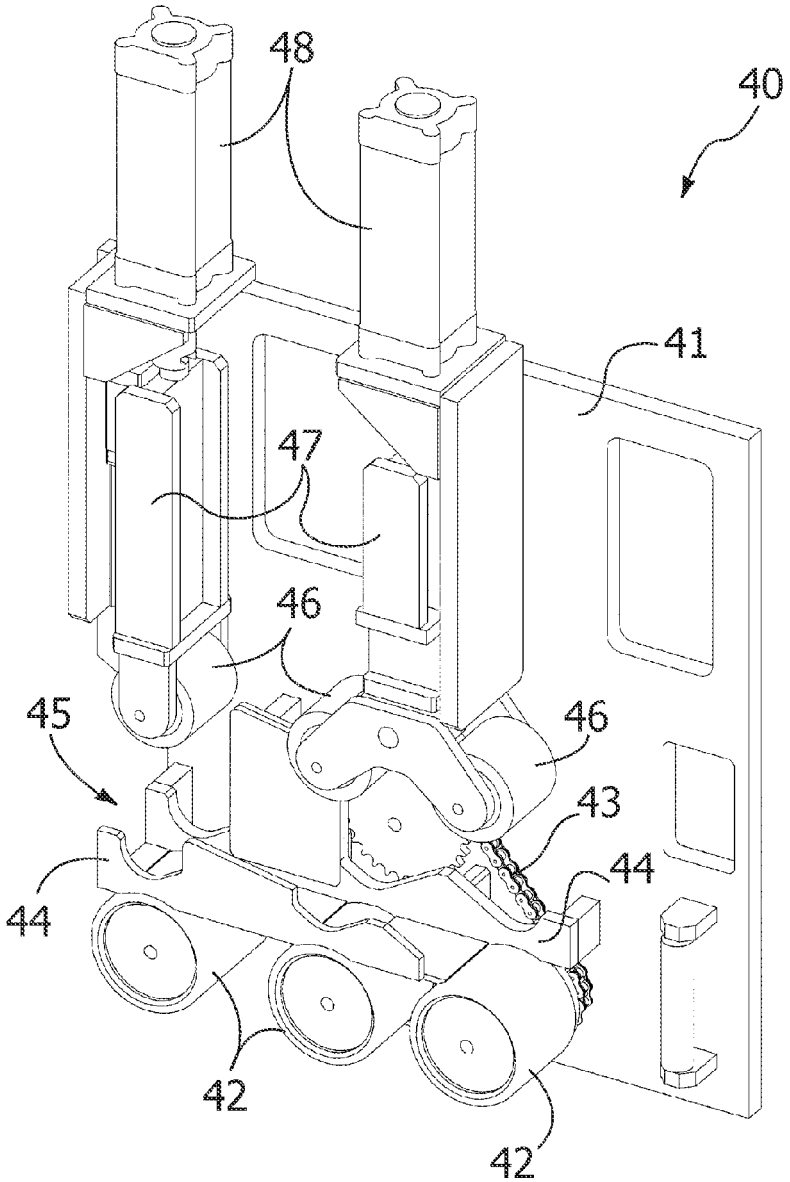


FIG. 11A

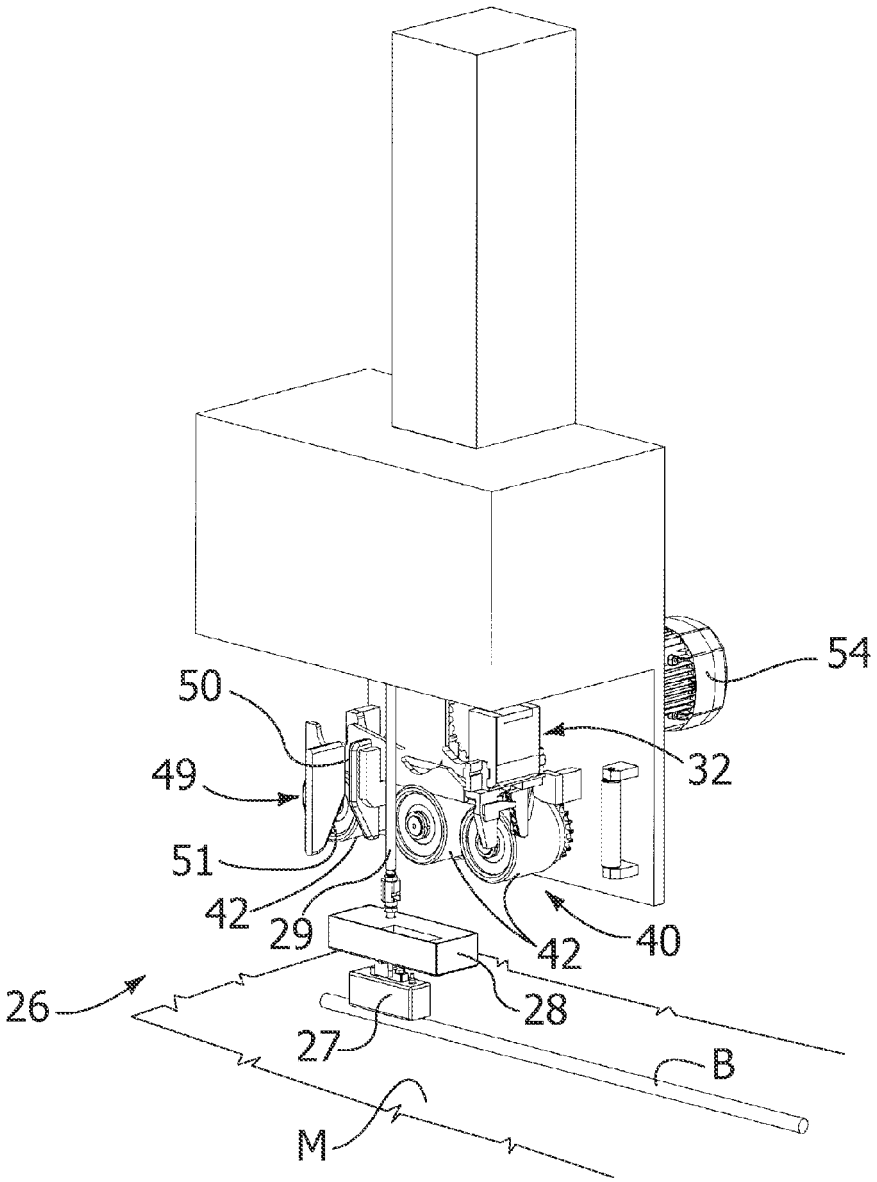


FIG. 11B

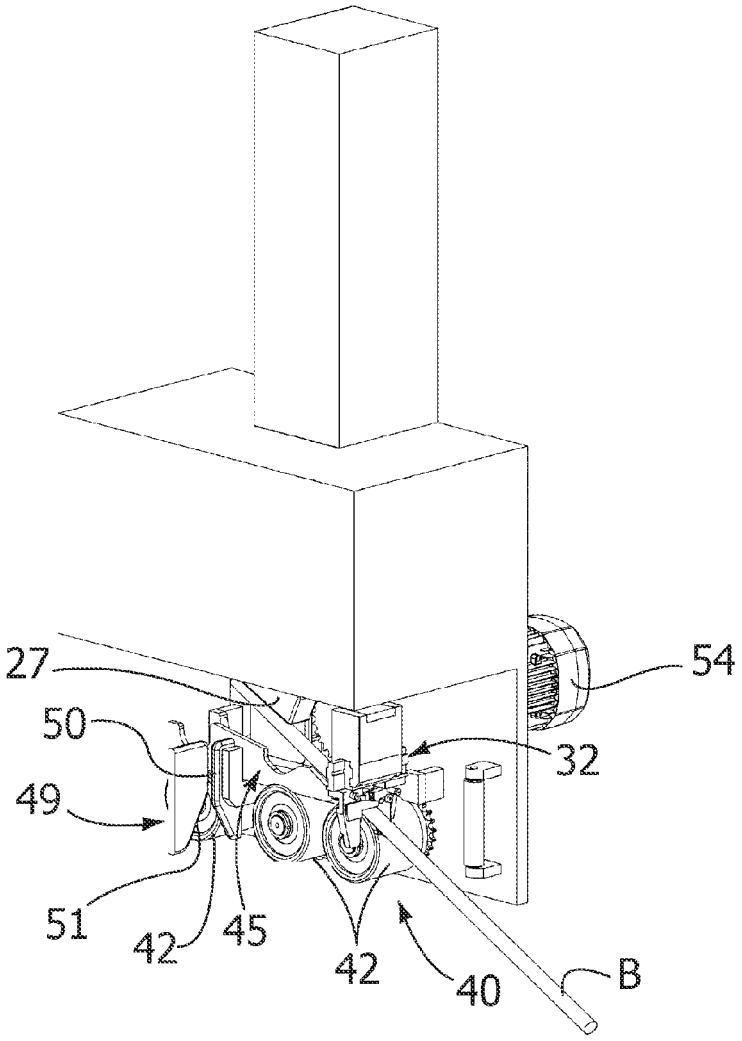


FIG. 11C

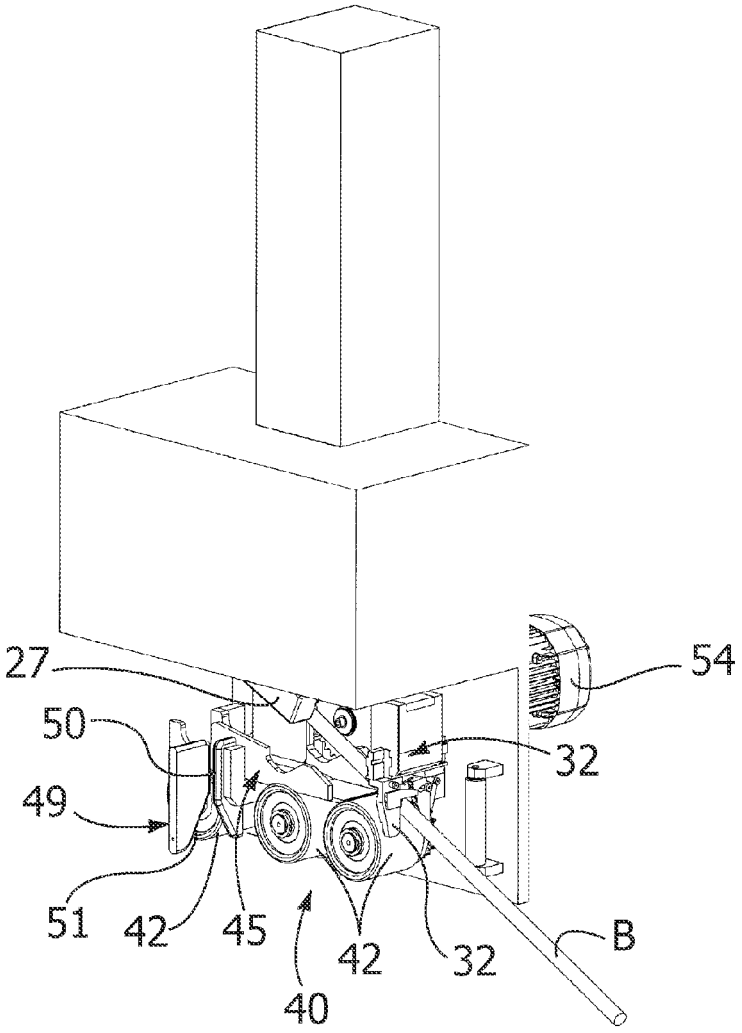


FIG. 11D

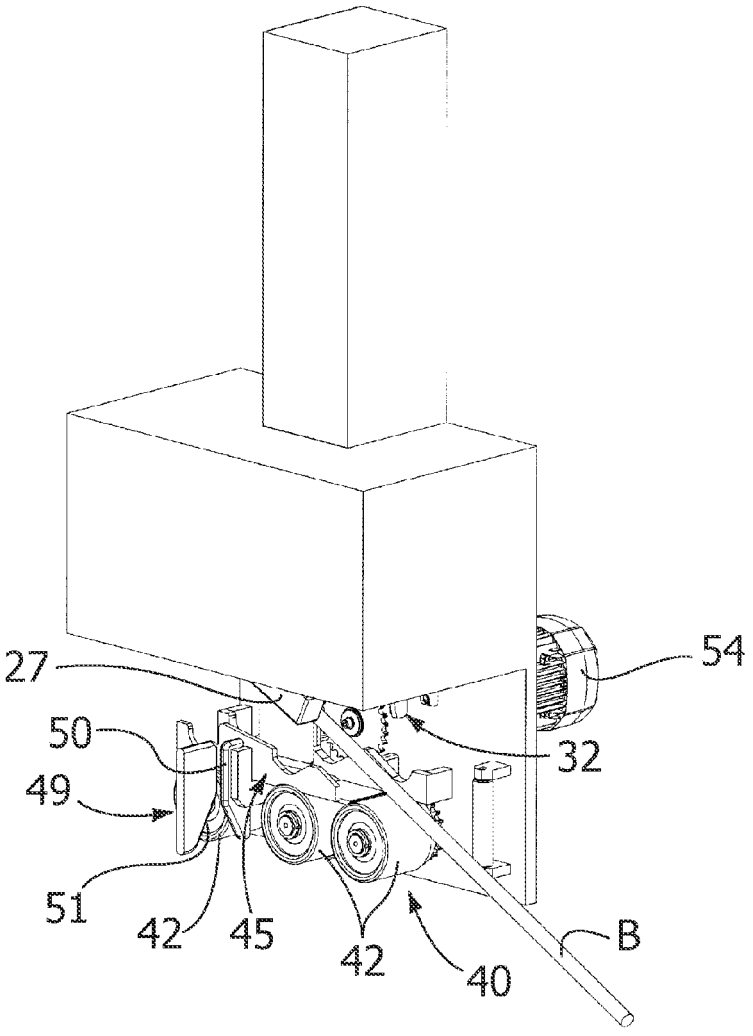


FIG. 11E

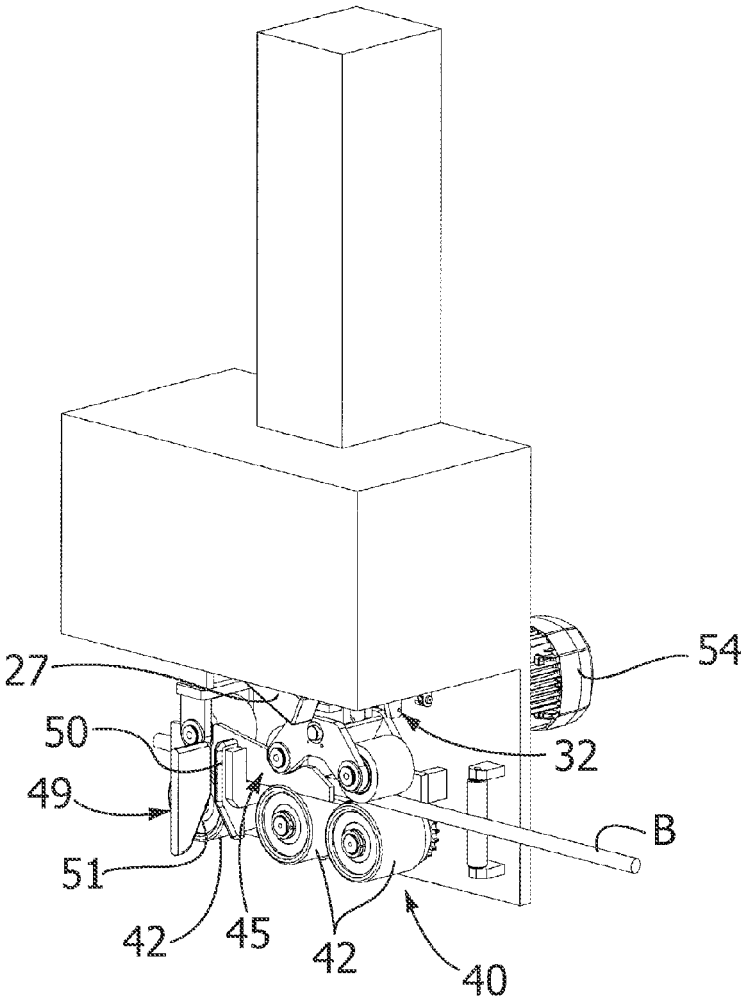
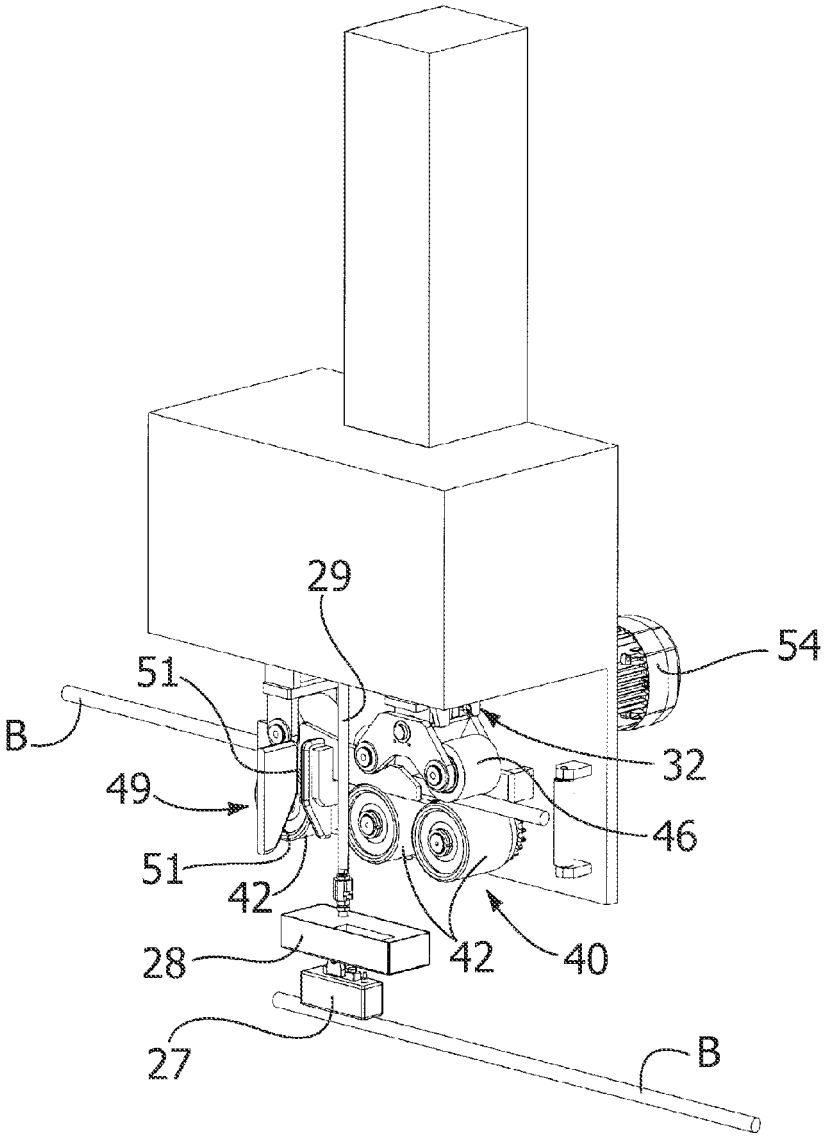


FIG. 11F



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B21F
B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 June 2011	Augé, Marc

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Application Number
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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
Munich	15 June 2011	Augé, Marc

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