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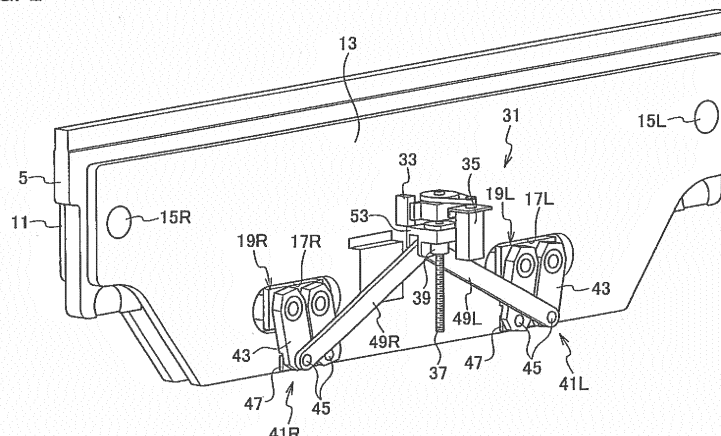
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(54) **PRESS BRAKE CROWNING METHOD USING FORCE-INCREASING MECHANISM, AND PRESS BRAKE**

(57) Provided are a crowning method and a press brake wherein, when crowning with a lower table is performed, the crowning is performed while rotating eccentric shafts using a force-increasing mechanism. In this press brake crowning method a front plate 11 and a back plate 13 are provided respectively at the front and back of a lower table 5, which is supported by left and right side frames 3L and 3R in a press brake 1, and crowning is performed while rotating eccentric shafts 23, which are

provided in the lower table 5 with intervals therebetween in the left-right directions. A force-increasing mechanism 41 is provided between each eccentric shaft 23 and an actuator 31 for rotating each eccentric shaft 23, the output of the actuator 31 is increased by the force-increasing mechanism 41 and is transmitted to each eccentric shaft 23, and each eccentric shaft 23 is rotated, thereby performing crowning.

FIG. 2



Description

TECHNICAL FIELD

[0001] The present invention relates to a press brake crowning method and a press brake, and in further detail, relates to a crowning method and a press brake in which, at a time of performing a crowning of a lower table by rotating an eccentric shaft, the crowning is performed by rotating said eccentric shaft with a force increased by a force-increasing mechanism (servo mechanism).

BACKGROUND ART

[0002] As is well-known, the press brake is equipped with C-shaped left and right side frames. On a lower front side of the side frames, a lower table is provided. Then, on an upper front side of the side frames, an upper table facing with the lower table is provided to be freely movable up or down. In the press brake of the above described configuration, a plate shaped workpiece is mounted and positioned on a lower mold installed on said lower table. Then, by pressing said workpiece by an upper mold provided in the upper table, a bending processing of the workpiece is carried out by a cooperation of the upper and lower molds.

[0003] In carrying out the bending processing of the workpiece as described above, both end sides in left and right of the lower table are fixed to the left and right side frames, and both end sides in left and right of the upper table are supported to be freely movable up or down on said side frames. Consequently, due to a reaction force at a time of carrying out the bending processing of the workpiece, the central portions of the upper and lower tables have a tendency to be curved in directions for mutually separating. Therefore, when the bending processing of the workpiece is carried out, a bending angle in vicinity of the central portion of the workpiece becomes looser (larger) than bending angles in vicinity of the both end portions in left and right, and the workpiece becomes vessel shaped.

[0004] For this reason, at a time of carrying out the bending processing of the workpiece, curving the central portion of the lower table in an upper direction, in correspondence to the curving of the upper table in the upper direction, so as to maintain the curving of the upper and lower tables to be parallel, i.e., the crowning, has been performed. Curving the central portion of the lower table in the upper direction will require a large force, so that a hydraulic cylinder has been used as an actuator.

[0005] In the case of performing the crowning operation by suing the hydraulic cylinder as described above, the hydraulic cylinder is prone to be of a large size, so that a maintenance and management of an overall configuration become cumbersome, and there is also a problem of a temperature rise of a hydraulic operating oil. For this reason, performing the crowning by rotating an eccentric shaft has been proposed (see Patent Documents

1 and 2, for example).

PRIOR ART DOCUMENT

5 PATENT DOCUMENT

[0006]

Patent Document 1: Japanese Patent Application publication No. 2000-343127

Patent Document 2: Japanese Patent Application publication No. 2015-178131

15 **[0007]** A configuration described in said Patent Documents 1 and 2 is a configuration in which an output shaft of a motor and an eccentric shaft are directly coupled via a coupling. Consequently, a large size motor is used as the motor, and there has been a desire for downsizing the motor in order to realize an energy saving and a compactness of the overall configuration.

SUMMARY OF THE INVENTION

25 **[0008]** The present invention has been made in view of the problems as described above, and its object is to provide a press brake crowning method and a press brake capable of realizing a downsizing and a compactness of an actuator, and capable of realizing an energy saving.

30 **[0009]** According to one aspect of the present invention, there is provided a press brake crowning method for a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake crowning method in which a force-increasing mechanism is provided between an actuator for rotating an eccentric shaft provided with said lower table in order to perform a crowning of said lower table and said eccentric shaft, an output of said actuator is transmitted to said eccentric shaft with a force increased by said force-increasing mechanism, and the crowning is performed by rotating said eccentric shaft.

40 **[0010]** According to another aspect of the present invention, there is provided a press brake crowning method for a press brake equipped with a front plate and a back plate arranged on a front and a back of a lower table that is supported by left and right side frames in the press brake, in which a crowning is performed by rotating a plurality of eccentric shafts provided with said lower table with intervals in a left-right direction, which is the press brake crowning method in which a force-increasing

mechanism is provided between an actuator for rotating said each eccentric shaft and said each eccentric shaft, an output of said actuator is transmitted to said each eccentric shaft with a force increased by said force-increasing mechanism, and the crowning is performed by rotating said each eccentric shaft.

[0011] Also, preferably, in said press brake crowning method, said force-increasing mechanism is in a configuration equipped with each lever member integrally provided with said each eccentric shaft which is extended in a direction intersecting with respect to left and right shaft centers of each eccentric shaft, each link member with a tip end portion pivotally connected to a tip end portion of said each lever member, and an actuator for pushing or pulling a pivotally connected base end portion side of said each link member in a direction intersecting with respect to a longitudinal direction of each link member, and the crowning is performed by rotating each eccentric shaft synchronously in respective reverse direction when said each eccentric shaft provided with intervals in left and right is rotated.

[0012] According to another aspect of the present invention, there is provided a press brake crowning method for a press brake equipped with a front plate and a back plate arranged on a front and a back of a lower table that is supported by left and right side frames in the press brake, in which a crowning is performed by rotating each eccentric shaft mechanism provided with said lower table with intervals in a left-right direction, which is the press brake crowning method in which a force-increasing mechanism is respectively provided between a respective actuator for rotating said each eccentric shaft mechanism individually and said each eccentric shaft mechanism, an output of said each actuator is transmitted to said each eccentric shaft mechanism with a force increased by said each force-increasing mechanism, and the crowning is performed by rotating said each eccentric shaft mechanism individually.

[0013] Also, preferably, in said press brake crowning method, each eccentric shaft mechanism provided with intervals in a left-right direction is in a configuration respectively equipped with a pair of left and right eccentric shafts to be freely rotatable, and the crowning is performed by rotating each eccentric shaft synchronously in respective reverse direction when a pair of left and right eccentric shafts are rotated by said each force-increasing mechanism.

[0014] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which an eccentric shaft for performing a crowning of

said lower table is provided to be freely rotatable on said lower table, and a force-increasing mechanism for transmitting an output of an actuator to said each eccentric shaft with a force increased is provided between the actuator for rotating said eccentric shaft and said eccentric shaft.

[0015] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, and a force-increasing mechanism for transmitting an output of an actuator to said each eccentric shaft with a force increased is provided between the actuator for rotating said eccentric shafts and said each eccentric shaft.

[0016] Also, preferably, in said press brake, said force-increasing mechanism is in a configuration with each lever member integrally provided with each eccentric shaft which is provided to be extended in a direction intersecting with respect to left and right shaft centers of each eccentric shaft, and each link member with a tip end portion pivotally connected to a tip end portion of said each lever member, in which a pivotally connected base end portion side of said each link member in a direction intersecting with respect to a longitudinal direction of each link member is pushed or pulled by said actuator.

[0017] Also, preferably, in said press brake, each eccentric shaft in left and right is in a configuration respectively equipped with a plurality of eccentric shafts arranged in parallel in a left-right direction, and the plurality of eccentric shafts provided to be arranged in parallel are in a configuration for being rotated in an identical direction synchronously.

[0018] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which left and right eccentric shaft mechanisms for performing a crowning of said lower table are provided to be freely rotatable on said lower table with intervals in a left-right direction, and a force-increasing mechanism for transmitting an output of each actuator to said each eccentric shaft mechanism with a force increased is provided between said each actuator provided individually

and said each eccentric shaft mechanism, so as to operate said each eccentric shaft mechanism individually.

[0019] Also, preferably, in said press brake, said force-increasing mechanism is configured with a toggle mechanism.

[0020] Also, preferably, in said press brake, said eccentric shaft is in a configuration equipped with a plurality of eccentric shafts arranged in parallel in a left-right direction, and said toggle mechanism is in a configuration equipped with a tip end portion of each link member pivotally connected to a tip end portion of each lever member that is integrally provided with each eccentric shaft provided to be arranged in parallel, in which a pivotally connected base end side portion of said each link member is pushed or pulled by said actuator.

[0021] Also, preferably, in said press brake, said actuator is a servo motor, and a member to push or pull the pivotally connected portion of said each link member is a ball nut screwed to be freely reciprocating with a ball screw to be rotated by said servo motor.

[0022] Also, preferably, in said press brake, said ball screw is arranged within a plane parallel to a plate surface of the lower table, and a rotational axis of the servo motor is arranged within a plane parallel to a plate surface of said lower table.

[0023] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, both end sides of a freely expansion operable connection member are provided to be connected to free end sides in each force-increasing link mechanism with a base end side connected to said left and right eccentric shafts, and an actuator for performing an expansion or contraction operation of said connection member is provided at said connection member.

[0024] Also, preferably, in said press brake, said connection member is in a configuration equipped with ball screw mechanisms at both end sides, and equipped with actuators for operating the ball screw mechanisms on both end sides individually.

[0025] Also, preferably, in said press brake, said force-increasing link mechanism is equipped with a tip end portion of each link member pivotally connected to a tip end portion of a respective lever member with a base end portion connected to each eccentric shaft provided adjacently, one link member in said each link member is provided to be longer than another link member, a base end portion side of another link member is provided to

be pivotally connected at a middle position in said one link member, and an end portion of said connection member is connected to a base end portion side in said one link member.

[0026] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, a force-increasing mechanism for transmitting an output of an actuator to said each eccentric shaft with a force increased is provided between the actuator for rotating said each eccentric shaft and said eccentric shaft, and a biasing means for assisting an operation of said actuator when said eccentric shaft is rotated by said actuator is provided.

[0027] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, both end sides of a freely expandable connection member are provided to be connected to free end sides in each force-increasing link mechanism with a base end side connected to said left and right eccentric shafts, it is in a configuration equipped with ball screw mechanisms at both end sides of this connection member, actuators for operating the ball screw mechanisms at the both end sides individually are provided, and a biasing means for assisting an operation of each actuator when said each force-increasing link mechanism is operated by said each actuator is provided.

[0028] According to another aspect of the present invention, there is provided a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, which is the press brake in which left and right eccentric shafts for performing a crowning of said lower table are provided to be freely

rotatable on said lower table, both end sides of a freely expandable connection member are provided to be connected to free end sides in each force-increasing link mechanism with a base end side connected to said left and right eccentric shafts, actuators for rotating ball screw mechanisms provided at this connection member are provided at said connection member, and a biasing means for assisting operations of said actuators when said each force-increasing link mechanism is operated by said actuators via said connection member is provided at each force-increasing link mechanism.

[0029] Also, preferably, in said press brake, said biasing means is a compression spring.

[0030] According to the present invention, at a time of performing the crowning of the press brake by rotating the eccentric shaft, the force-increasing mechanism is interposed between the actuator for rotating the eccentric shaft and the eccentric shaft, and the output of the actuator is transmitted with a force increased. Consequently, it is possible to provide a press brake crowning method and a press brake capable of realizing a downsizing and a compactness of an actuator, and capable of realizing an energy saving.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Fig. 1 is a perspective view schematically showing an overall configuration of a press brake according to an embodiment of the present invention.

Fig. 2 is a perspective view of a configuration for performing a crowning of a lower table, viewed from a rear side (back side) of the lower table.

Fig. 3 is a perspective view of a part of an eccentric shaft unit according the first embodiment, viewed from a back side in cross section.

Fig. 4 is a diagram showing a configuration of a force-increasing (servo) mechanism of the first embodiment, for rotating the eccentric shaft provided in the eccentric shaft unit.

Fig. 5 is a diagram showing a configuration of a force-increasing (servo) mechanism of the second embodiment, for rotating the eccentric shaft provided in the eccentric shaft unit.

Fig. 6 is a rear side (back side) perspective view of the lower table, showing a configuration according to the third embodiment.

Fig. 7 is a diagram showing the lower table according to the third embodiment, where (a) is a plan view and (b) is a rear side (back side) view.

Fig. 8 is a rear side perspective view showing a configuration of the lower table according to the fourth embodiment.

Fig. 9 is a diagram showing a configuration of the lower table according to the fifth embodiment, where (a) is a plan view and (b) is a rear side view.

Fig. 10 is a perspective view of a toggle mechanism

shown in Fig. 9.

Fig. 11 is a cross sectional plan view of a toggle mechanism shown in Fig. 9.

Fig. 12 is a plan view of a toggle mechanism shown in Fig. 9.

Fig. 13 is a rear side view showing a configuration of a toggle mechanism portion.

Fig. 14 is a rear side perspective view showing a configuration of the lower table according to the sixth embodiment.

Fig. 15 is a rear side view showing a configuration of a toggle mechanism shown in Fig. 14.

Fig. 16 is a rear side view showing an operation state of a toggle mechanism shown in Fig. 14.

Fig. 17 is a rear side view showing an operation state of a toggle mechanism shown in Fig. 14.

Fig. 18 is a rear side view showing a configuration of the lower table according to the seventh embodiment.

Fig. 19 is a diagram showing a configuration of the lower table according to the seventh embodiment, where (a) is a plan view and (b) is a rear side view.

Fig. 20 is a rear side view showing an operation state of a toggle mechanism.

Fig. 21 is a rear side view showing an operation state of a toggle mechanism.

EMBODIMENTS FOR IMPLEMENTING THE INVENTION

[0032] In the following, the press brake according to embodiments of the present invention will be described by using the drawings. An overall configuration of the press brake is a well-known configuration, but an overall configuration of the press brake will be described briefly in order to facilitate the understanding.

[0033] Referring to Fig. 1, a press brake 1 according to an embodiment of the present invention is equipped with C-shaped left and right side frames 3L and 3R on both sides in a left-right direction (X-axis direction). On a lower front side of these side frames 3L and 3R, both end sides in left and right of a plate shaped lower table 5 are supported. Then, on an upper front side of said side frames 3L and 3R, both end sides in left and right of an upper table 7 as a ram are supported to be freely movable up or down. In order to move this upper table 7 up or down, on an upper front side of said side frames 3L and 3R, ram lifting and lowering operation devices 9L and 9R configured from a hydraulic cylinder, a ball screw mechanism and the like, for example, are installed.

[0034] In the above described configuration, a plate shaped workpiece is mounted and positioned on a lower mold (omitted to be shown in the figure) installed on the lower table 5. Then, the workpiece is pressed by lowering an upper mold (omitted to be shown in the figure) installed on the upper table 7. In this way, when the workpiece is pressed, the bending processing of the workpiece is carried out by a cooperation of the upper and lower molds.

[0035] As described above, when the bending processing of the workpiece is carried out by the upper and lower molds installed on the upper and lower tables 7 and 5, the central portions in the left-right direction of the upper and lower tables 7 and 5 have a tendency to be curved in directions for mutually separating due to a reaction force. Therefore, in order to carry out the bending processing of the workpiece, while maintaining the upper and lower molds installed on the upper and lower tables 7 and 5 in a parallel state, a crowning for curving the central portion in the left-right direction of the lower table 5 into a convex shape in an upper direction is performed.

[0036] More specifically, said lower table 5 is attached to the lower front side of said side frames 3L and 3R via bolts and the like (omitted to be shown in the figure). Then, on a front and a back of said lower table 5, a front plate 11 and a back plate 13 are provided. Said front plate 11 and back plate 13 of the lower table 5 are integrally provided via left and right pivots 15L and 15R that are piercing through them respectively in a front-back direction.

[0037] On left and right symmetric positions between which a central position in the left-right direction (X-axis direction) in said press brake 1 is present, nearly rectangular shaped piercing holes 17L and 17R that are piercing through said front plate 11, the lower table 5 and the back plate 13 in the front-back direction are formed. Within these piercing holes 17L and 17R, eccentric shaft units (eccentric shaft mechanisms) 19L and 19R for pushing the lower table 15 in the upper direction with respect to said front plate 11 and back plate 13 and curving the central portion of the lower table 15 into a convex shape in the upper direction are internally installed.

[0038] More specifically, said eccentric shaft units 19L and 19R are provided, as shown in Fig. 3, with front and back bearing blocks 21F and 21B separated in front and back for which movements in an up-down direction are regulated within the piercing holes 17L and 17R in said front plate 11 and back plate 13. In other words, plate thicknesses of the front and back bearing blocks 21F and 21B are thicknesses nearly equal to plate thicknesses of said front plate 11 and back plate 13. Then, an interval in the front-back direction is provided to be nearly equal to an interval in the front-back direction between said front plate 11 and back plate 13. On said bearing blocks 21F and 21B, both end sides in front and back of a pair of left and right eccentric shafts 23 in an identical configuration are supported to be freely rotatable.

[0039] More specifically, on said bearing blocks 21F and 21B, bearing flanges 25 are provided respectively, and both end sides in front and back of the eccentric shaft 23 are supported to be freely rotatable on these bearing flanges 25. Then, between the front and back bearing flanges 25, an eccentric portion 23E of a large diameter is provided in said eccentric shaft 23. On this eccentric portion 23E, a lifting and lowering block 29 is supported via a plurality of bearings 27.

[0040] Said lifting and lowering block 29 is arranged to

be capable of moving up or down between the front and back bearing blocks 21F and 21B. Then, on an upper side of the lifting and lowering block 29, a pressing plate 29A for pressing an upper side in the piercing holes 17L and 17R formed on the lower table 5 is provided. Note that said lifting and lowering block 29 has its rotation regulated so as not to follow at a time of the rotation of the eccentric shaft 23. Then, between a lower side of said lifting and lowering block 29 and a lower side of the piercing holes 17L and 17R in the lower table 5, a clearance for permitting the lower table 5 to move up or down by the rotation of said eccentric shaft 23 is provided.

[0041] As will be understood from the above described configuration, when respective eccentric shafts 23 provided in the eccentric shaft units 19L and 19R are rotated in the identical direction, each lifting and lowering block 29 will be moving up or down with respect to the front and back bearing blocks 21F and 21B. Here, the bearing blocks 21F and 21B in the eccentric shaft units 19L and 19R are in a state of having an up and down movement regulated by the front plate 11 and the back plate 13, so that at a time of the up movement of said lifting and lowering block 29, the lower table 5 will be pressed in the upper direction with respect to the front plate 11 and the back plate 13. Namely, the crowning operation will be performed.

[0042] By the way, said eccentric shaft units 19L and 19R are in a configuration equipped with a plurality of eccentric shafts 23, so that a load at a time of performing the crowning by pressing the lower table 5 in the upper direction is shared by each eccentric shaft 23. Consequently, comparing to the case of using a single configuration for the eccentric shaft, it is possible to make each eccentric shaft 23 thinner, so that it is possible to realize a compactness by suppressing a height dimension in the up-down direction. Note that the left and right eccentric shaft units 19L and 19R provided within the left and right piercing holes 17L and 17R will have their operation directions to be mutually reverse directions in a left and right symmetric configuration.

[0043] In order to actuate the left and right eccentric shaft units 19L and 19R synchronously, as shown in Fig. 2, an actuation device (actuator) 31 is provided on a back side of said back plate 13. More specifically, on the back side of said back plate 13, a support bracket 33 is attached, and on this support bracket 33, a servo motor 35 is installed. Also, on said support bracket 33, a ball screw 37 to be rotated by said servo motor 35 is provided to be vertical and freely rotatable. Then, on this ball screw 37, a nut member 39 is screwed to be freely movable up or down. Consequently, when said servo motor 35 is forwardly or reversely rotated, the ball screw 37 is forwardly or reversely rotated, and the nut member 39 is moved up or down.

[0044] In order to rotate each eccentric shaft 23 in said left and right eccentric shaft units 19L and 19R, between said actuation device 31 and each eccentric shaft 23, force-increasing mechanisms (servo mechanisms) 41L

and 41R are provided. This force-increasing mechanism 41 has a function for transmitting the output of said actuation device 31 to said each eccentric shaft 23 with a force increased, and in the present embodiment, it is configured from a toggle mechanism, which is configured as follows.

[0045] Namely, as shown in Fig. 4, on a rear end portion of each eccentric shaft 23 in the left and right eccentric shaft units 19L and 19R, a base end portion of a long lever member 43 extended in a direction intersecting (orthogonal) with respect to an axial center of each eccentric shaft 23 is fixed integrally. Then, a tip end portion of said each lever member 43 in respective eccentric units 19L and 19R is pivotally connected to a connection member 47 via a hinge pin 45. Namely, tip end portions of respective lever members 43 are pivotally connected with each other via the connection member 47.

[0046] Then, to said hinge pins 45 in the left and right force-increasing mechanisms 41L and 41R, tip end portions of left and right link members 49L and 49R are pivotally connected. Base end portion sides of these left and right respective link members 49L and 49R are pivotally connected with each other via a pivot 51. Then, to said pivot 51, a push and pull member 53 for pushing and pulling this pivot 51 in the upper direction, i.e., a direction intersecting with respect to a longitudinal direction of said respective link members 49L and 49R, is pivotally attached. Said push and pull member 53 is attached to said nut member 39 in said actuation device 31 as an example of the actuator as shown in Fig. 2.

[0047] Consequently, when said servo motor 35 is driven and said ball screw 37 is rotated forwardly or reversely to move the nut member 39 up or down, said push and pull member 53 will be integrally moved up or down. As will be understood from Fig. 4, when said push and pull member 53 is lowered from a lifted position, the left and right link members 49L and 49R will have an included angle between these link members 49L and 49R becoming gradually larger. Namely, it is going to be rotated by pressing the tip end portions of the respective lever members 43 in the left and right eccentric shaft units 19L and 19R in the outer directions, which is pressing such that the tip end portions of the respective lever members 43 are separated from each other.

[0048] As described above, respective lever members 43 in the left and right eccentric shaft units 19L and 19R are rotated. Consequently, respective eccentric shafts 23 in the left and right eccentric shaft units 19L and 19R are rotated in respectively reverse directions synchronously. In this way, when each eccentric shaft 23 is rotated, each eccentric portion 23E in each eccentric shaft 23 is gradually lifted from a lowered position. Thus, the crowning is performed as the lower table 5 is pressed in the upper direction by the pressing plate 29A provided at each lifting and lowering block 29 in the left and right eccentric shaft units 19L and 19R.

[0049] As mentioned above, when the crowning is performed by rotating respective eccentric shafts 23, said

eccentric shafts 23 are rotated via the force-increasing mechanisms 41L and 41R configured from toggle mechanisms. Consequently, when the eccentric shafts are rotated, they are rotated by increasing force of the output of said actuation device 31. Thus, it is possible to realize the downsizing and the compactness of said actuation device 31. Note that the actuation device (actuator) for moving up or down (pushing or pulling) said push and pull member 53 is not to be limited to the above described configuration, and it is also possible to use the fluid pressure cylinder and the like, for example.

[0050] By the way, in the above described explanation, the case of actuating the respective eccentric shafts 23 provided in the left and right eccentric shaft units 19L and 19R by the common actuation device 31 has been described. However, as shown in Fig. 5, it is also possible to actuate the respective eccentric shafts 23 in the left and right eccentric shaft units 19L and 19R individually by separate actuation devices.

[0051] Referring to Fig. 5, the left and right eccentric shaft units 55L and 55R corresponding to the left and right eccentric shaft units 19L and 19R described above are internally installed in said piercing holes 17L and 17R, similarly as said eccentric shaft units 19L and 19R. In said eccentric shaft units 55L and 55R, left and right eccentric shafts 57L and 57R corresponding to said eccentric shafts 23 are respectively provided. These eccentric shafts 57L and 57R differ from the configuration of the eccentric shaft units 19L and 19R described above in that they are configured to be left-right symmetric, and that they are configured to be rotated in mutually reverse directions. However, the remaining configuration is identical in configuration and identical in function, so that the explanation about details of the eccentric shaft units 55L and 55R will be omitted.

[0052] To the respective eccentric shafts 57L and 57R provided in said left and right eccentric shaft units 55L and 55R, base end portions of the left and right lever members 59L and 59R corresponding to said lever members 43 are integrally attached. Then, to tip end portions of said respective lever members 59L and 59R, tip end portions of link members 61L and 61R corresponding to said link members 49L and 49R are pivotally connected via hinge pins 63. The base end portions of said link members 61L and 61R are pivotally connected to a push and pull member 67 via pivots 65. Said push and pull member 67 corresponds to the push and pull member 53 described above. A configuration of an actuation device (actuator) 69 for moving said push and pull member 67 up or down is a similar configuration as the actuation device 31 described above, so that constituent elements for realizing identical functions will be given the identical reference numerals and the overlapping explanation will be omitted. Note that the nut member 39 and the push and pull member 67 are integrally connected via a connection rod 71.

[0053] By the above described configuration, the lever members 59L and 59R and the link members 61L and

61R for rotating a pair of left and right eccentric shafts 57L and 57R in the left and right eccentric shaft units 55L and 55R constitute toggle mechanisms 73L and 73R as an example of the force-increasing mechanism. Consequently, when the servo motors 35 in the left and right actuation devices 69 are driven and the ball screw 37 are rotated forwardly or reversely, the nut member 39 is moved up or down. Thus, the link members 61L and 61R are pushed or pulled via the push and pull member 67.

[0054] As apparent from Fig. 5, when said push and pull member 67 is lowered from a lifted position, the lever members 59L and 59R and the link members 61L and 61R in the left and right toggle mechanisms 73L and 73R are rotated such that lower end sides are separated from each other. Namely, a pair of the eccentric shafts 57L and 57R provided in the left and right eccentric shaft units 55L and 55R are rotated in mutually reverse directions. Then, the eccentric portions provided in the respective eccentric shafts 57L and 57R are gradually lifted from lower sides, and the lower table 5 is pressed in the upper direction.

[0055] As described above, when the lower end sides of the respective link members 61L and 61R are rotated such that they are separated from each other, the included angle between the respective link members 61L and 61R becomes gradually larger. Consequently, the output of said servo motor 35 is transmitted from the ball screw 37 and the nut member 39 to the eccentric shafts 57L and 57R via the toggle mechanisms 73L and 73R. Namely, the output of the servo motor 35 is transmitted to the eccentric shafts 57L and 57R with force increased. Thus, it is possible to realize the downsizing and the compactness of the servo motor 35.

[0056] By the way, in the configuration shown in Fig. 5, actuation devices 69 for actuating the left and right eccentric shaft units 55L and 55R are provided individually. Consequently, it is possible to actuate the left and right eccentric shaft units 55L and 55R individually. Namely, it is possible to perform the crowning on left side and on right side individually in the lower table 5.

[0057] Consequently, in the case of sequentially carry out the bending processing of the workpiece on left side, at central portion, and on right side of the lower table 5, for example, as in the step bending, for example, the crowning becomes possible in correspondence to a position of the bending processing of the workpiece. Therefore, the bending processing in higher precision becomes possible.

[0058] Note that the present invention is not to be limited only to the embodiment described above, and can be practiced in other embodiments by making appropriate modifications. Namely, for the force-increasing mechanism, instead of the toggle mechanism as described above, it is possible to use a configuration having a large diameter sector gear as the eccentric shaft, in which this sector gear is rotated by a small diameter gear, or a configuration in which a sector gear is formed as a worm gear, which is rotated by a worm.

[0059] Furthermore, it is also possible for a configuration of the force-increasing mechanism (servo mechanism) to be a configuration for rotating the eccentric shaft via a lever crank mechanism utilizing "leverage", for example.

[0060] Also, a location for providing said actuator is not to be limited to the back plate, and it is also possible to be the front plate. Moreover, it is also possible to be a part of the frames such as the left and right side frames.

[0061] Note that, in the explanation described above, the case where the eccentric shaft units 55L and 55R for performing the crowning of the lower table 5 has been described. However, in the case where the press brake is of a small size, it is also possible to use a configuration in which the eccentric shaft unit is provided at one location in central portion of the lower table 5. Also, in the case where the lower table 5 is lengthy in a left-right direction, it is also possible to use a configuration in which the eccentric shaft units are provided at three locations at central portion and on both sides in left and right of the lower table 5. Namely, it is possible to make the number of the eccentric shaft units to be a desired number.

[0062] Fig. 6 shows a configuration of a force-increasing (servo) mechanism of the third embodiment, for rotating the eccentric shafts provided in the eccentric shaft units. In this embodiment, those constituent elements for realizing identical functions as the constituent elements in the embodiments described above will be given the identical reference numerals and the overlapping explanation will be omitted.

[0063] In this third embodiment, within the piercing holes 17L and 17R formed on the front plate 11, the lower table 5 and the back plate 13, the eccentric shaft units 55L and 55R are arranged. Then, on the left and right eccentric shafts 57L and 57R provided in these eccentric shaft units 55L and 55R (see Fig. 7(b)), the base end portions of the lever members 59L and 59R that constitute parts of the long toggle mechanisms 73L and 73R that are the force-increasing mechanisms are attached integrally.

[0064] Then, at the tip end portions of the respective lever members 59L and 59R, the tip end portions of the link members 61L and 61R are pivotally connected via the hinge pins 63. In the link members 61L and 61R described above, the link member 61R on one side is configured to be longer than the link member 61L on the other side. Then, the base end portion in the link member 61L on the other side is pivotally connected to a middle position of the link member 61R on one side via a pivot 81.

[0065] In the above described configuration, the lever members 59L and 59R and the link members 61L and 61R constitute force-increasing link mechanisms (the toggle mechanisms 73L and 73R). Then, to the tip end portions (free end portions) of the left and right link members 61R in the left and right force-increasing link mechanisms, both end portions of a freely expandable con-

nection member 83 for rotating the eccentric shafts 57L and 57R via the force-increasing link mechanisms are pivotally connected via pivots 85. The connection member 83 described above is divided into a first connection portion 83A provided with a ball screw 87 to be freely rotatable, and a second connection portion 83B provided with a ball nut 89 screwed with said ball screw 87. Then, on said first connection portion 83A, a servo motor 91 for rotating said ball screw 87 is provided.

[0066] Consequently, by adjusting a screwed state of said ball screw 87 and ball nut 89 by driving said servo motor 91 in rotations, it is possible to adjust an entire length of said connection member 83. Thus, it is possible to rotate the eccentric shafts 57L and 57R in the left and right eccentric shaft units 55L and 55R by the servo motor 91. Namely, it is possible to perform the crowning adjustment of the lower table 5 by driving the left and right eccentric shaft units 55L and 55R.

[0067] Fig. 8 shows the fourth embodiment for rotating the eccentric shafts provided in the eccentric shaft units. In this embodiment, it is a configuration in which the connection member 83 for actuating the left and right eccentric shaft units 55L and 55R via the left and right toggle mechanisms 73L and 73R is divided into three.

[0068] Namely, to the link members 61R in the toggle mechanisms 73L and 73R, end portions of the first connection portions 83A provided with the ball screws 87 are pivotally connected respectively. Then, between the first connection portions 83A on both sides, the second connection portion 83B provided on both end portions with the ball nuts 89 screwed with the ball screws 87 is arranged.

[0069] With the configuration described above, by driving the ball screws 87 in rotations by the servo motors 91 respectively provided on both sides of the first connection portion 83A, it is possible to expand or contract and actuate the connection member 83. Consequently, it is possible to perform the crowning of the lower table 5 by rotating the eccentric shafts provided in the left and right eccentric shaft units 55L and 55R.

[0070] In the configuration described above, as it is a configuration provided with a plurality of the servo motors 91, it is possible to realize the downsizing of the servo motors 91. Note that, for a configuration for expanding or contracting the connection member 83, instead of the ball screw mechanism described above, it is also possible to use an expandable fluid pressure cylinder, for example.

[0071] Fig. 9 shows the fifth embodiment. In this fifth embodiment, it is a configuration in which the left and right eccentric shaft units 55L and 55R provided within the left and right piercing holes 17L and 17R formed through the front plate 11, the lower table 5 and the back plate 13 are actuated individually by the left and right toggle mechanisms 93L and 93R.

[0072] Since the left and right toggle mechanisms 93L and 93R are in configurations which are identical or left-right symmetric, a configuration of the toggle mechanism

93L on one side will be explained, and an explanation will be omitted for a configuration of the toggle mechanism 93R on the other side. Also, those constituent elements for realizing identical functions as the constituent elements in the embodiments described above will be given the identical reference numerals and the overlapping explanation will be omitted.

[0073] Referring to Fig. 10, in the eccentric shaft unit 55L to be actuated by the toggle mechanism 93L, the left and right eccentric shafts 57L and 57R are provided (see Fig. 11), and to these eccentric shafts 57L and 57R, the base end portions of the lever members 59L and 59R are attached. To the tip end portions of the lever members 59L and 59R described above, tip end portions of T-shaped link members 95L and 95R are pivotally connected via the hinge pins 63 (see Fig. 13). Then, base end portions of the link members 95L and 95R described above are pivotally connected to the push and pull member 67 via the pivot 65.

[0074] The push and pull member 67 described above is moved up or down by the servo motor 35 attached to the back plate 13. Namely, said servo motor 35 is supported by the support bracket 33 attached to the back side of said back plate 13. Then, to said support bracket 33, the ball screw 37 to be rotated by the servo motor 35 is supported vertically and to be freely rotatable. With this ball screw 37, the nut member 39 integrally connected to said push and pull member 67 is screwed to be freely movable up or down.

[0075] Consequently, as the ball screw 37 is rotated forwardly or reversely by the servo motor 35, the push and pull member 67 will be moved up or down via the nut member 39. Thus, the eccentric shafts 57L and 57R in the eccentric shaft unit 55L are rotated via the toggle mechanism 93L configured from the link members 95L and 95R and the lever members 59L and 59R.

[0076] As should be understood already, the eccentric shafts 57L and 57R are rotated by said servo motor 35 as an actuator. As described above, at a time of rotating the eccentric shafts 57L and 57R by the servo motor 35, a biasing means for assisting the operation of said servo motor 35 is provided.

[0077] Namely, on sides in the left-right direction of said link members 95L and 95R, end portion plates 99 are provided. These end portion plates 99 are integrally provided on both end portions of a plurality of guide rods 97 that are long in the left-right direction. In a middle position in the left-right direction of said guide rods 97, left and right slide plates 101 with L-shape in cross section that are freely moving closer or apart are supported to be freely movable.

[0078] Then, to the left and right slide plates 101, tip end portions of arm portions 95LA and 95RA provided on said link members 95L and 95R are pivotally connected via pivots 102. The arm portions 95LA and 95RA described above are provided to be protruding in a direction intersecting with respect to a longitudinal direction of the link members 95L and 95R. Consequently, said link

members 95L and 95R are having the T-shape.

[0079] Between said end portion plates 99 and said slide plates 101, a plurality of coil springs 103 are installed. These coil springs 103 constitute the biasing means for assisting the operation of said servo motor 35. Namely, the coil springs 103 are already compressed, and always functioning in a direction for moving the left and right slide plates 101 closer to each other.

[0080] Also, on portions of the hinge pins 63 described above, seating plates 105 (see Fig. 13) are respectively provided. Then, between these seating plates 105, a plurality of coil springs 107 as the biasing means are installed.

[0081] In said configuration, when the push and pull member 67 is moved up or down in Fig. 13 by actuating said servo motor 35, the pivot 65 pivotally attaching the left and right link members 95L and 95R will be moved up or down. Consequently, the eccentric shafts 57L and 57R in the eccentric shaft unit 55L are rotated via the link members 95L and 95R and the lever members 59L and 59R.

[0082] As described above, when the eccentric shafts 57L and 57R are rotated via the push and pull member 67, that is, at a time of performing the crowning of the lower table 5 by lowering the push and pull member 67 in Fig. 13, respective coil springs 103 assist the left and right slide plates 101 by pressing in a direction of moving closer to each other. Also, the coil springs 107 assist the left and right hinge pins 63 in a direction of moving apart.

[0083] Namely, the respective coil springs 103 and 107 as the biasing means are going to assist the driving of the servo motor 35 at a time of performing the crowning of the lower table 5. Consequently, it is possible to realize the downsizing of the servo motor 35, and it is possible to realize the energy saving. Also, in said configuration, the left and right eccentric shaft units 55L and 55R can be actuated individually. Therefore, in the case of carrying out the step bending of the workpiece by changing a position in the left-right direction of the lower table 5, it is possible to perform the crowning of the lower table 5 in correspondence to each bending processing position.

[0084] Fig. 14 shows the sixth embodiment. This embodiment corresponds to a combination of the embodiment described above and shown in Figs. 9 to 13 and the embodiment of the connection member 83 in the embodiment shown in Fig. 8. Consequently, constituent elements for realizing identical functions will be given the identical reference numerals and the overlapping explanation will be omitted.

[0085] In this sixth embodiment, it is a configuration in which the left and right toggle mechanisms 93L and 93R are operated to be interlocking. Namely, in this sixth embodiment, the servo motor 35 in the embodiment shown in Fig. 9 is omitted. Then, in the link member 95L in the toggle mechanisms 93L and 93R, the arm portion 95LA is formed to be largely protruding in an upper direction from a portion of the pivot 102, as shown in Fig. 15. In the configuration described above, it is a configuration in

which the connection member 83 according to the embodiment shown in Fig. 8 is provided at the left and right arm portions 95LA.

[0086] Even in this sixth embodiment, the plurality of coil springs 103 and 107 are going to be assisting the operation of the servo motor 91, so that the similar effect as described above can be realized.

[0087] Fig. 18 to Fig. 21 show the seventh embodiment. In this seventh embodiment, it is a configuration in which the coil springs as the biasing means are provided on the left and right toggle mechanisms 93L and 93R, and the left and right toggle mechanisms 93L and 93R are operated to be interlocking by a single servo motor.

[0088] More specifically, the toggle mechanisms 93L and 93R are such that the lever members 59L and 59R are attached to the respective eccentric shafts 57L and 57R in the left and right eccentric shaft units 55L and 55R (see Fig. 21), similarly as the configuration described above. Then, to said respective lever members 59L and 59R, the link members 61L and 61R are pivotally connected respectively via the hinge pins 63. The respective link members 61L and 61R described above are pivotally connected via the pivot 65. With the configuration described above, the toggle mechanisms 93L and 93R are configured by the respective lever members 59L and 59R and link members 61L and 61R.

[0089] Then, in order to operate the both toggle mechanisms 93L and 93R to be interlocking, to the tip end portion of the respective link member 61L in the both toggle mechanisms 93L and 93R, the connection member 83 is pivotally connected. Consequently, by expanding or contracting and actuating the connection member 83 as the ball screw 87 is rotated forwardly or reversely by the servo motor 91 provided on the connection member 83, the both toggle mechanisms 93L and 93R are actuated to be interlocking. Therefore, the crowning will be performed as the eccentric shafts 57L and 57R in the left and right eccentric shaft units 55L and 55R are rotated simultaneously in interlocked manner.

[0090] The biasing means for assisting the rotations of the eccentric shafts 57L and 57R at a time of performing the crowning as described above is configured as follows (see Fig. 20).

[0091] Namely, the biasing means is provided with biasing means 109A and 109B for respectively assisting the link members 61L and 61R individually. Namely, the biasing means 109A is provided with a seating plate 113 pivotally attached to be freely rotatable to the back plate 13 via a pivot 111. It is also provided with a seating plate 117 pivotally attached to the link member 61L via a pivot 115. Then, between said seating plates 113 and 117, coil springs 119 are installed. These coil springs 119 assist by operating to press the link member 61L.

[0092] The biasing means 109B is provided with a seating plate 123 pivotally attached to be freely rotatable to the back plate 13 via a pivot 121. It is also provided with a bracket 127 pivotally attached to the link member 61R via a pivot 125. Then, a rod 129 integrally provided

to this bracket 127 is piercing through said seating plat 123 to be freely slidable, and a seating plate 131 is provided at a tip end portion of this rod 129. Then, between said seating plate 123 and the seating plate 131, coil springs 133 are installed.

[0093] Namely, said biasing means 109B assist by operating to pull the link member 61R.

[0094] As should be understood from the above explanation, according to the present invention, at a time of performing the crowning by rotating the eccentric shafts in the press brake, the eccentric shafts are rotated via the toggle mechanism as an example of the force-increasing mechanism (servo mechanism). Therefore, it is possible to realize the downsizing of the actuator for rotating the eccentric shafts.

[0095] Also, it is provided with the biasing means for assisting the operation of the toggle mechanism (force-increasing link mechanism) for rotating said eccentric shafts. Therefore, by the synergy effect of the effect due to the toggle mechanism and the effect due to the biasing means, it is possible to make the actuator more downsized.

[0096] By the way, for said biasing means, it is not to be limited to the coil springs as described above, and it is also possible to use gas springs and the like, for example.

Claims

1. A press brake crowning method for a press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake crowning method **characterized in that** a force-increasing mechanism is provided between an actuator for rotating an eccentric shaft provided with said lower table in order to perform a crowning of said lower table and said eccentric shaft, an output of said actuator is transmitted to said eccentric shaft with a force increased by said force-increasing mechanism, and the crowning is performed by rotating said eccentric shaft.
2. A press brake crowning method for a press brake equipped with a front plate and a back plate arranged on a front and a back of a lower table that is supported by left and right side frames in the press brake, in which a crowning is performed by rotating a plurality of eccentric shafts provided with said lower table with intervals in a left-right direction, the press brake crowning method **characterized in that** a force-increasing mechanism is provided between an actuator for rotating said each eccentric shaft and said each eccentric shaft, an output of said actuator is transmitted to said each eccentric shaft with a force increased by said force-increasing mechanism, and the crowning is performed by rotating said each eccentric shaft.
3. In the press brake crowning method as described in claim 2, the press brake crowning method **characterized in that** said force-increasing mechanism is in a configuration equipped with each lever member integrally provided with said each eccentric shaft which is extended in a direction intersecting with respect to left and right shaft centers of each eccentric shaft, each link member with a tip end portion pivotally connected to a tip end portion of said each lever member, and an actuator for pushing or pulling a pivotally connected base end portion side of said each link member in a direction intersecting with respect to a longitudinal direction of each link member, and the crowning is performed by rotating each eccentric shaft synchronously in respective reverse direction when said each eccentric shaft provided with intervals in left and right is rotated.
4. A press brake crowning method for a press brake equipped with a front plate and a back plate arranged on a front and a back of a lower table that is supported by left and right side frames in the press brake, in which a crowning is performed by rotating each eccentric shaft mechanism provided with said lower table with intervals in a left-right direction, the press brake crowning method **characterized in that** a force-increasing mechanism is respectively provided between a respective actuator for rotating said each eccentric shaft mechanism individually and said each eccentric shaft mechanism, an output of said each actuator is transmitted to said each eccentric shaft mechanism with a force increased by said each force-increasing mechanism, and the crowning is performed by rotating said each eccentric shaft mechanism individually.
5. In the press brake crowning method as described in claim 4, the press brake crowning method **characterized in that** each eccentric shaft mechanism provided with intervals in a left-right direction is in a configuration respectively equipped with a pair of left and right eccentric shafts to be freely rotatable, and the crowning is performed by rotating each eccentric shaft synchronously in respective reverse direction when a pair of left and right eccentric shafts are rotated by said each force-increasing mechanism.
6. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames

in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** an eccentric shaft for performing a crowning of said lower table is provided to be freely rotatable on said lower table, and a force-increasing mechanism for transmitting an output of an actuator to said each eccentric shaft with a force increased is provided between the actuator for rotating said eccentric shaft and said eccentric shaft.

7. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, and a force-increasing mechanism for transmitting an output of an actuator to said each eccentric shaft with a force increased is provided between the actuator for rotating said eccentric shafts and said each eccentric shaft.
8. In the press brake as described in claim 7, the press brake **characterized in that** said force-increasing mechanism is in a configuration with each lever member integrally provided with each eccentric shaft which is provided to be extended in a direction intersecting with respect to left and right shaft centers of each eccentric shaft, and each link member with a tip end portion pivotally connected to a tip end portion of said each lever member, in which a pivotally connected base end portion side of said each link member in a direction intersecting with respect to a longitudinal direction of each link member is pushed or pulled by said actuator.
9. In the press brake as described in claim 7 or 8, the press brake **characterized in that** each eccentric shaft in left and right is in a configuration respectively equipped with a plurality of eccentric shafts arranged in parallel in a left-right direction, and the plurality of eccentric shafts provided to be arranged in parallel are in a configuration for being rotated in an identical direction synchronously.
10. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames

in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** left and right eccentric shaft mechanisms for performing a crowning of said lower table are provided to be freely rotatable on said lower table with intervals in a left-right direction, and a force-increasing mechanism for transmitting an output of each actuator to said each eccentric shaft mechanism with a force increased is provided between said each actuator provided individually and said each eccentric shaft mechanism, so as to operate said each eccentric shaft mechanism individually.

11. In the press brake as described in any one of claims 6 to 10, the press brake **characterized in that** said force-increasing mechanism is configured with a toggle mechanism.
12. In the press brake as described in claim 11, the press brake **characterized in that** said eccentric shaft is in a configuration equipped with a plurality of eccentric shafts arranged in parallel in a left-right direction, and said toggle mechanism is in a configuration equipped with a tip end portion of each link member pivotally connected to a tip end portion of each lever member that is integrally provided with each eccentric shaft provided to be arranged in parallel, in which a pivotally connected base end side portion of said each link member is pushed or pulled by said actuator.
13. In the press brake as described in any one of claims 7 to 11, the press brake **characterized in that** said actuator is a servo motor, and a member to push or pull the pivotally connected portion of said each link member is a ball nut screwed to be freely reciprocating with a ball screw to be rotated by said servo motor.
14. In the press brake as described in claim 13, the press brake **characterized in that** said ball screw is arranged within a plane parallel to a plate surface of the lower table, and a rotational axis of the servo motor is arranged within a plane parallel to a plate surface of said lower table.
15. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower

table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, both end sides of a freely expansion operable connection member are provided to be connected to free end sides in each force-increasing link mechanism with a base end side connected to said left and right eccentric shafts, and an actuator for performing an expansion or contraction operation of said connection member is provided at said connection member.

16. In the press brake as described in claim 15, the press brake **characterized in that** said connection member is in a configuration equipped with ball screw mechanisms at both end sides, and equipped with actuators for operating the ball screw mechanisms on both end sides individually.

17. In the press brake as described in claim 15 or 16, the press brake **characterized in that** said force-increasing link mechanism is equipped with a tip end portion of each link member pivotally connected to a tip end portion of a respective lever member with a base end portion connected to each eccentric shaft provided adjacently, one link member in said each link member is provided to be longer than another link member, a base end portion side of another link member is provided to be pivotally connected at a middle position in said one link member, and an end portion of said connection member is connected to a base end portion side in said one link member.

18. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, a force-increasing mechanism for transmitting an output of an actuator to said each eccentric shaft with a force increased is provided between the actuator for rotating said each eccentric shaft and said eccentric shaft, and a biasing means for assisting an operation of said actuator when said eccentric shaft is rotated by said actuator is provided.

19. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table

provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, both end sides of a freely expandable connection member are provided to be connected to free end sides in each force-increasing link mechanism with a base end side connected to said left and right eccentric shafts, it is in a configuration equipped with ball screw mechanisms at both end sides of this connection member, actuators for operating the ball screw mechanisms at the both end sides individually are provided, and a biasing means for assisting an operation of each actuator when said each force-increasing link mechanism is operated by said each actuator is provided.

20. A press brake equipped with a front plate and a back plate on a front and a back of a lower table that is attached to a lower side of left and right side frames in the press brake, and equipped with an upper table provided with an upper mold for carrying out a bending processing on a plate shaped workpiece in cooperation with a lower mold provided with this lower table, to be freely movable up or down on an upper side of said left and right side frames, the press brake **characterized in that** left and right eccentric shafts for performing a crowning of said lower table are provided to be freely rotatable on said lower table, both end sides of a freely expandable connection member are provided to be connected to free end sides in each force-increasing link mechanism with a base end side connected to said left and right eccentric shafts, actuators for rotating ball screw mechanisms provided at this connection member are provided at said connection member, and a biasing means for assisting operations of said actuators when said each force-increasing link mechanism is operated by said actuators via said connection member is provided at each force-increasing link mechanism.

21. In the press brake as described in any of claim 18, 19 or 20, the press brake **characterized in that** said biasing means is a compression spring.

FIG. 1

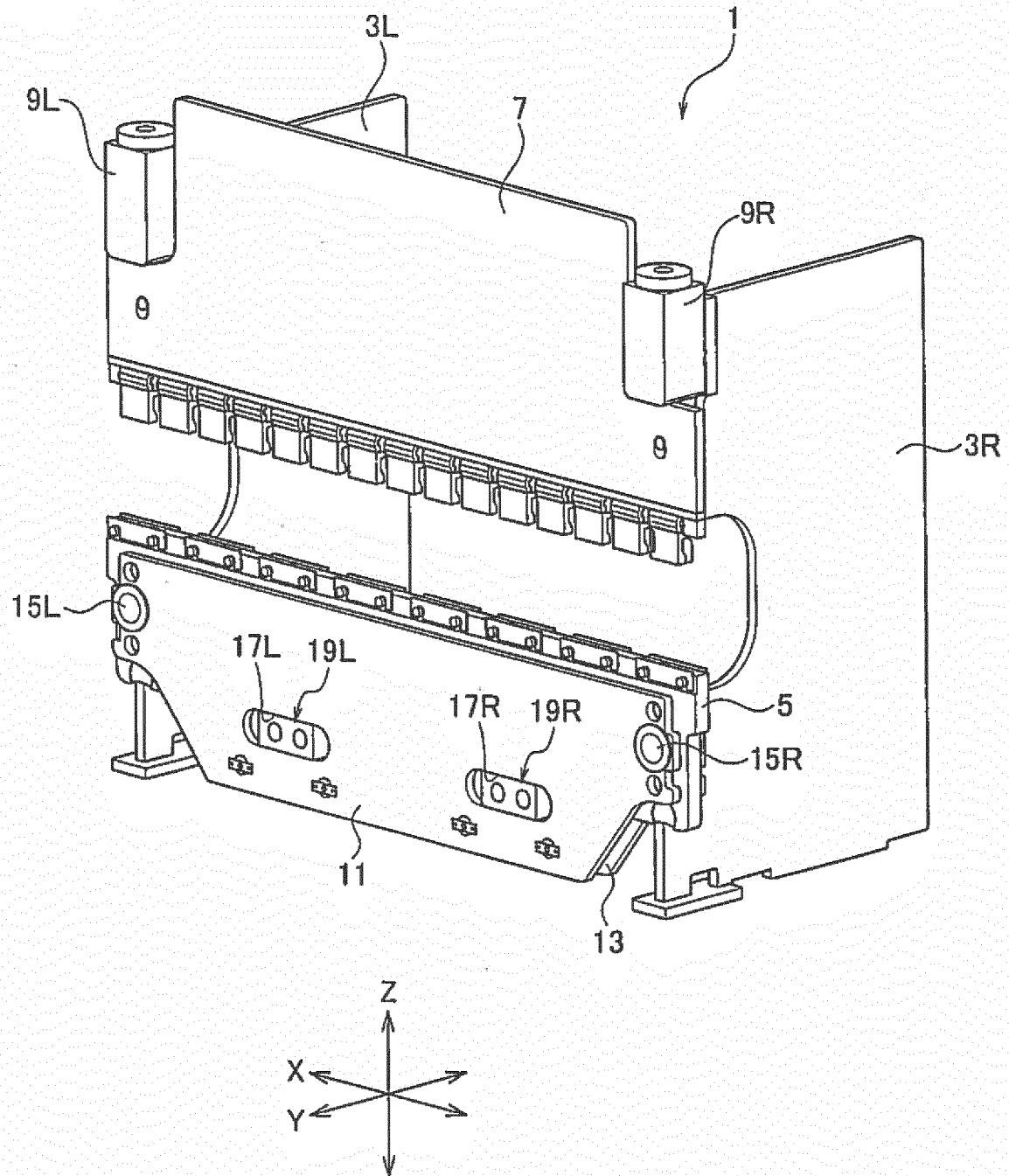


FIG. 2

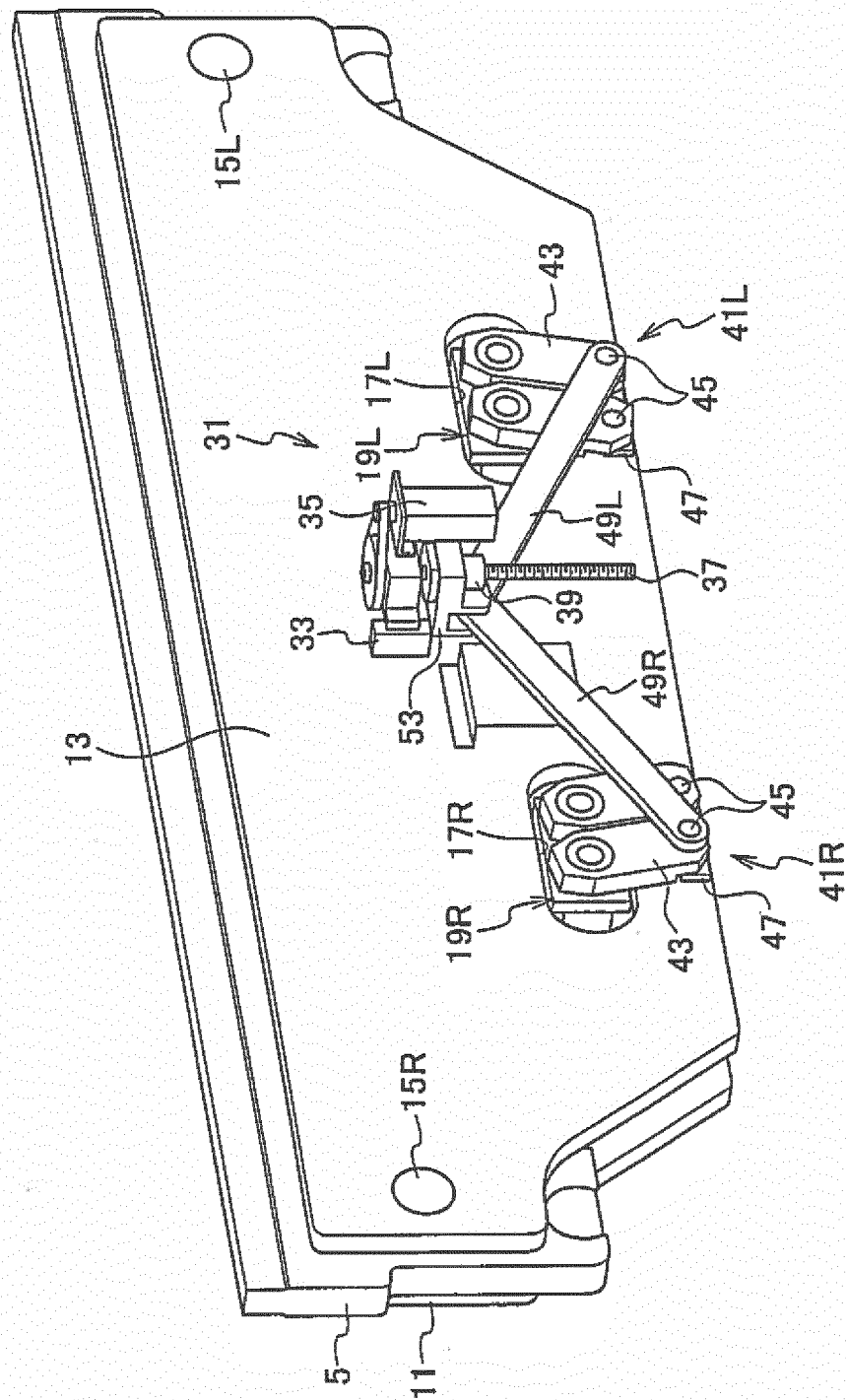


FIG. 3

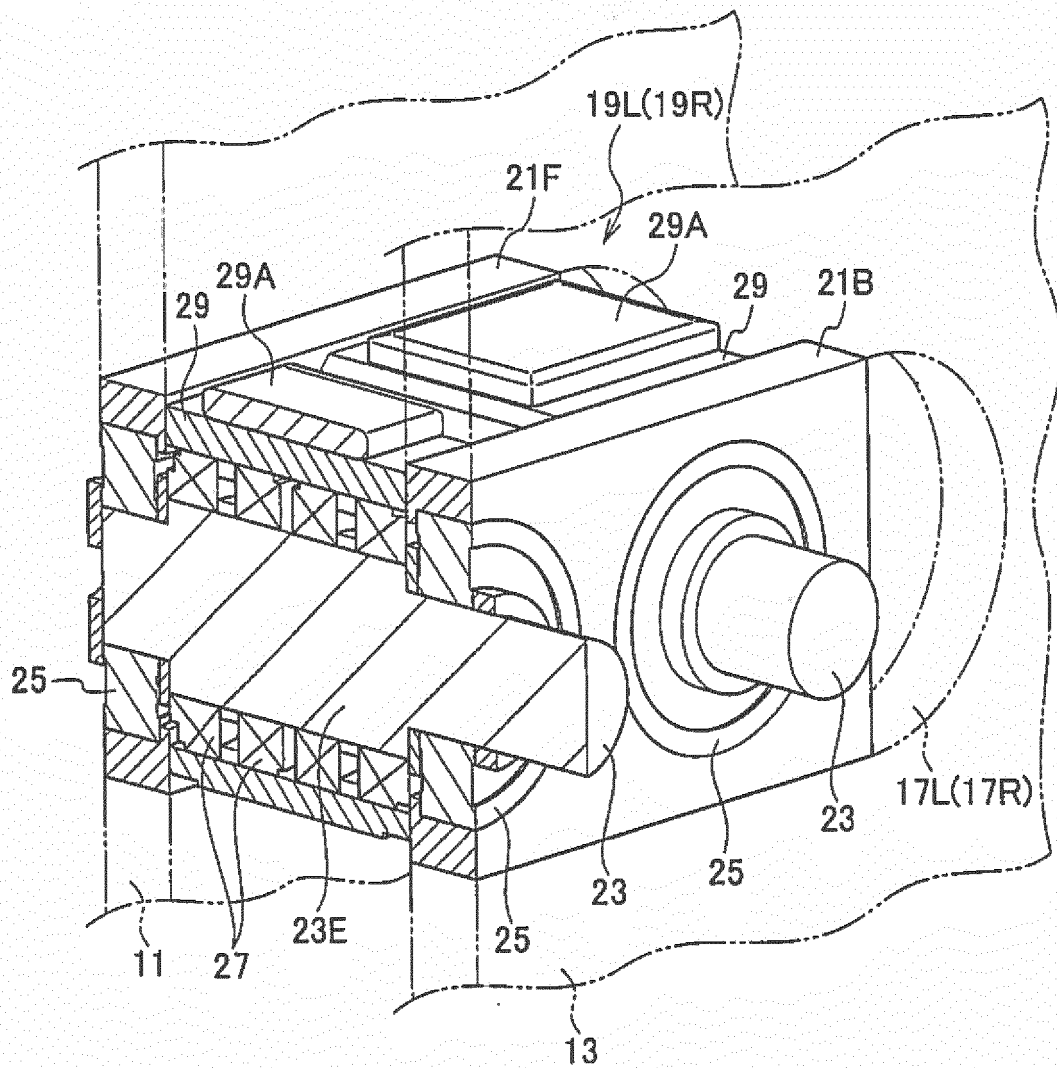


FIG. 4

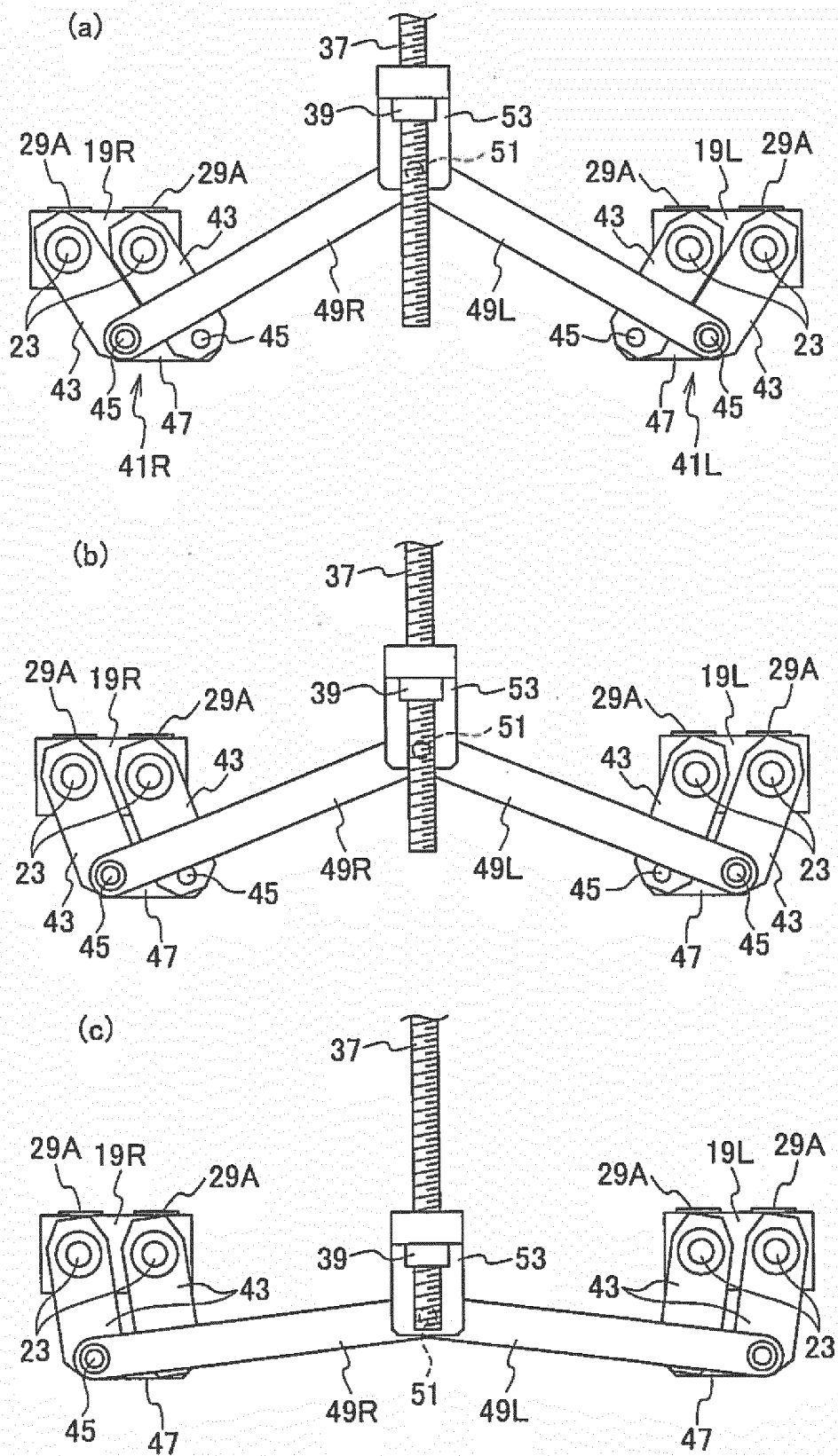
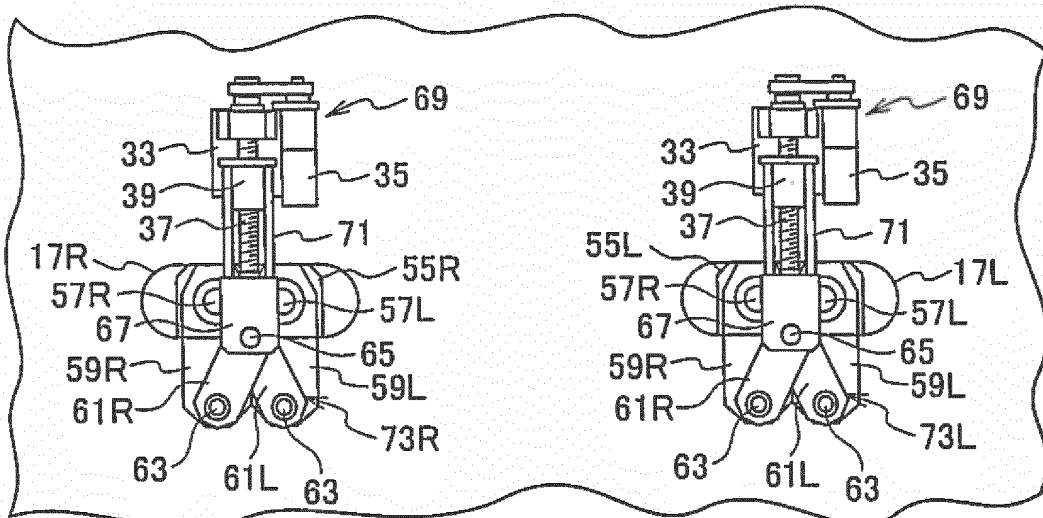
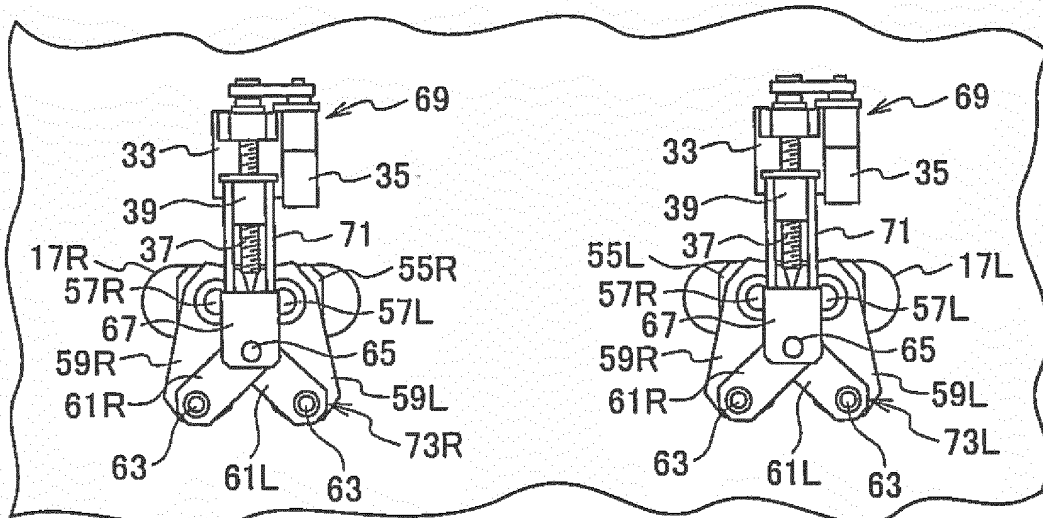


FIG. 5

(a)



(b)



(c)

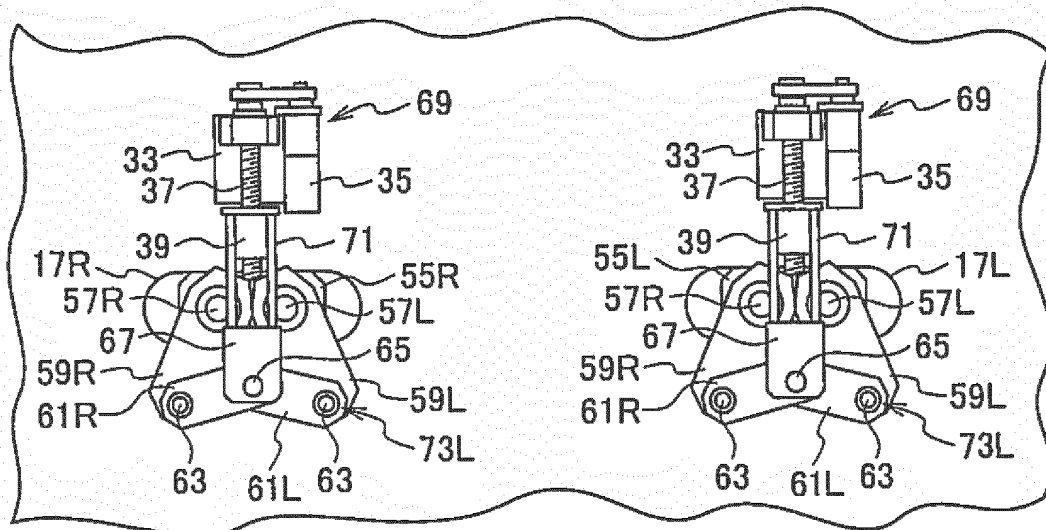


FIG. 6

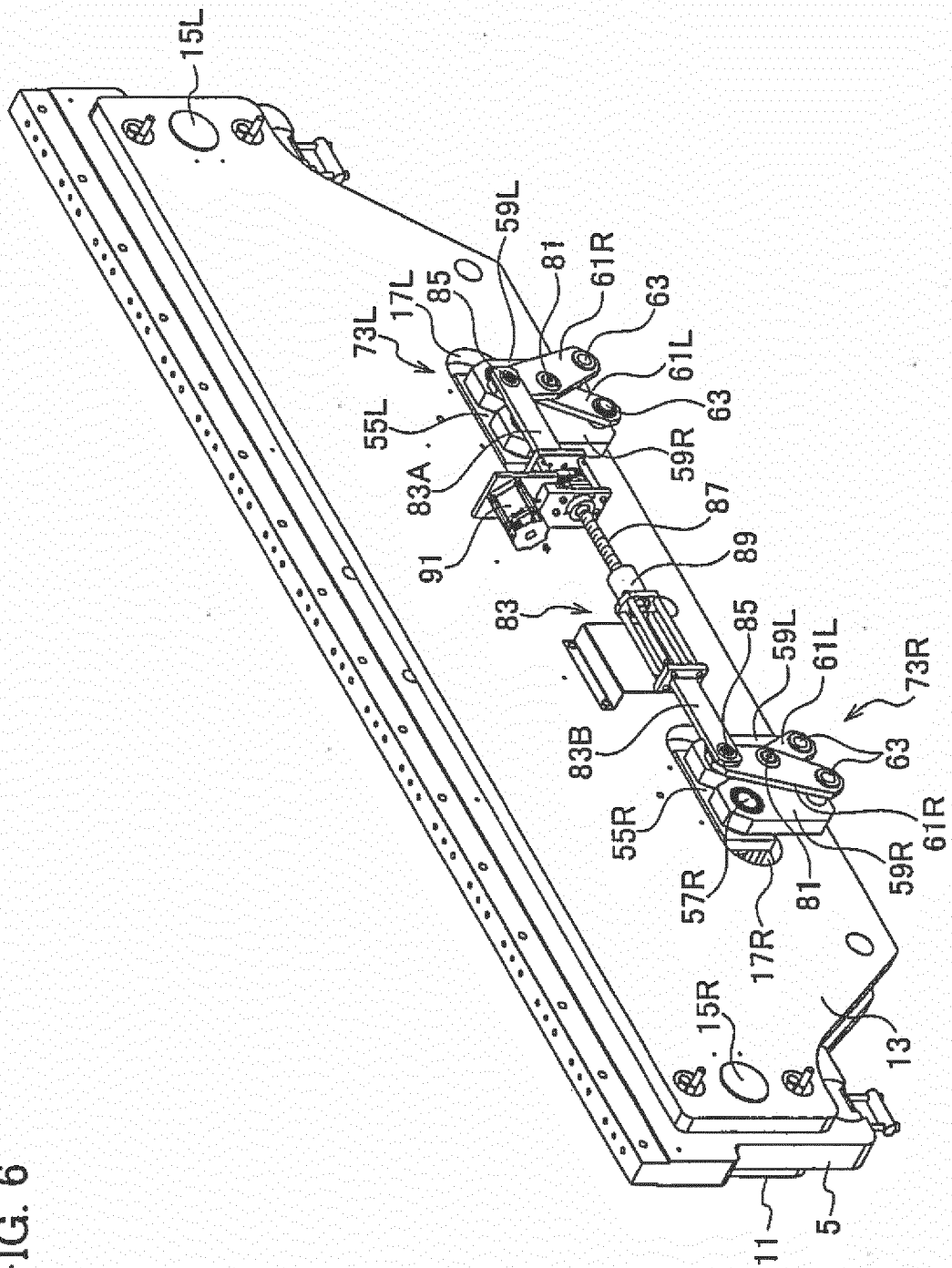


FIG. 7

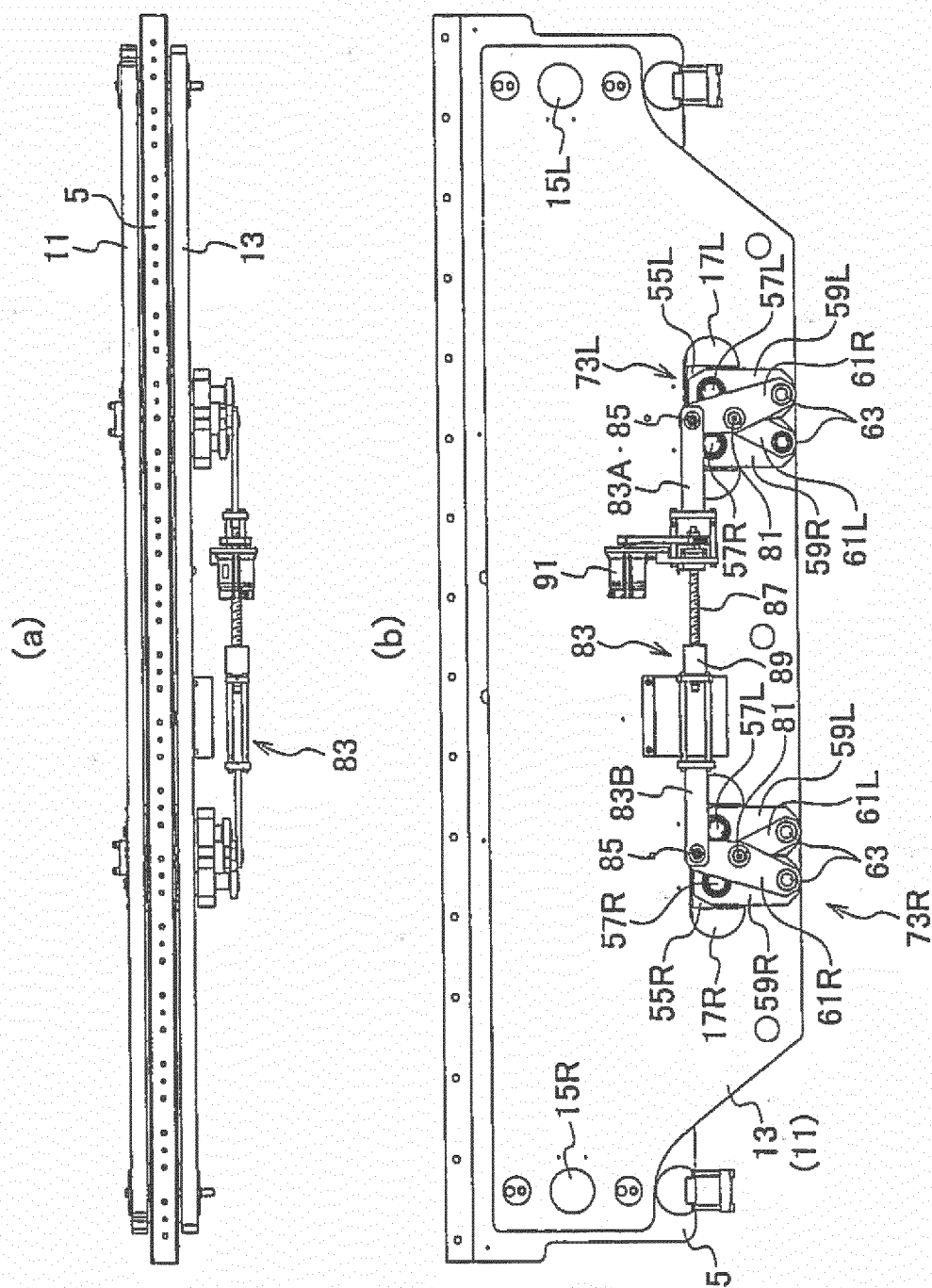


FIG. 8

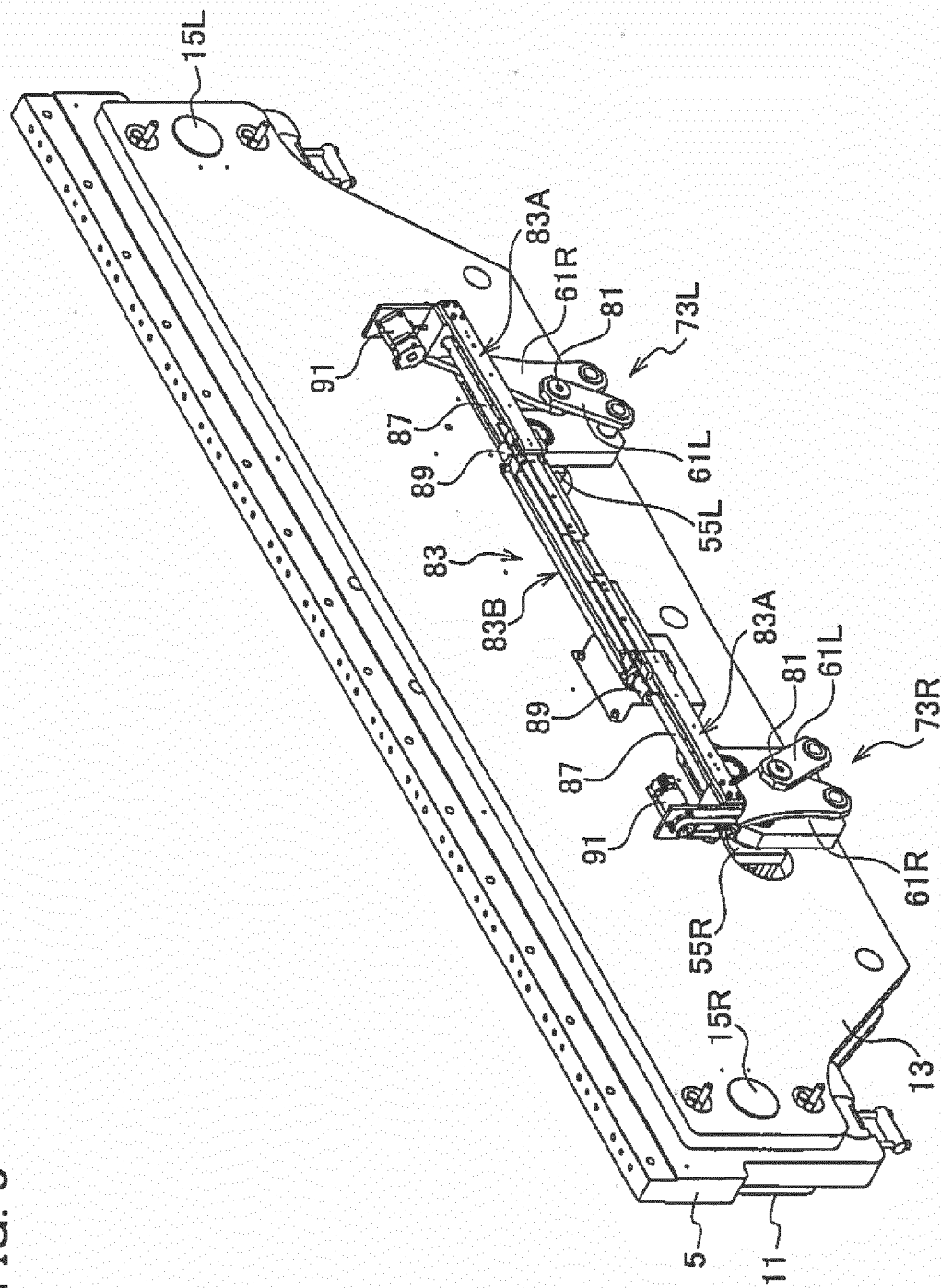


FIG. 9

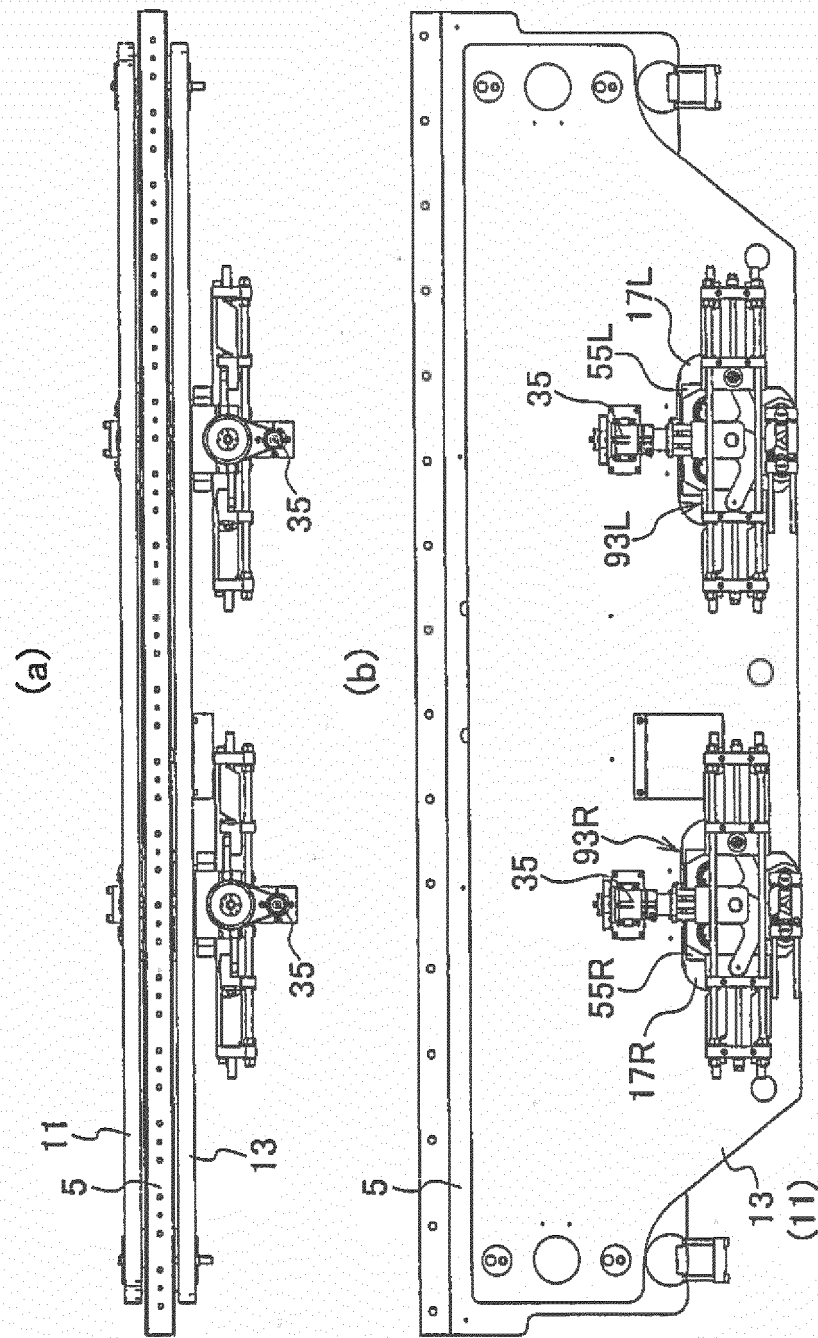


FIG. 10

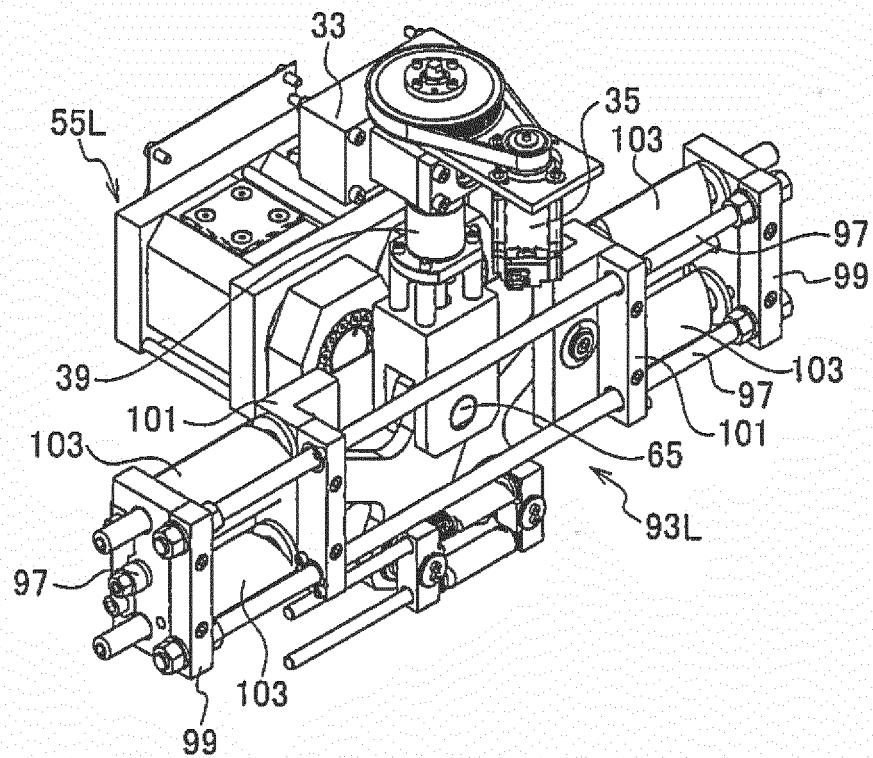


FIG. 11

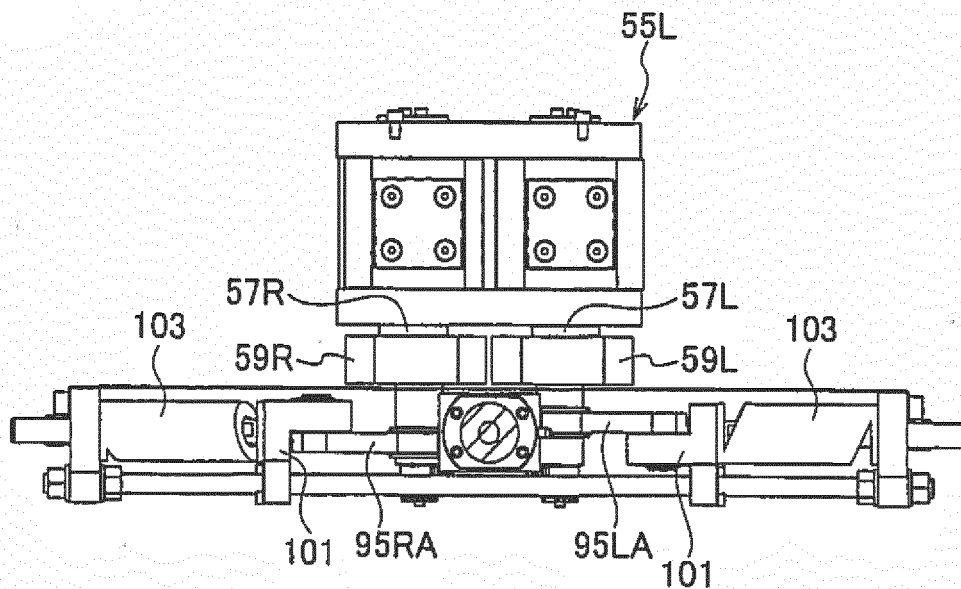


FIG. 12

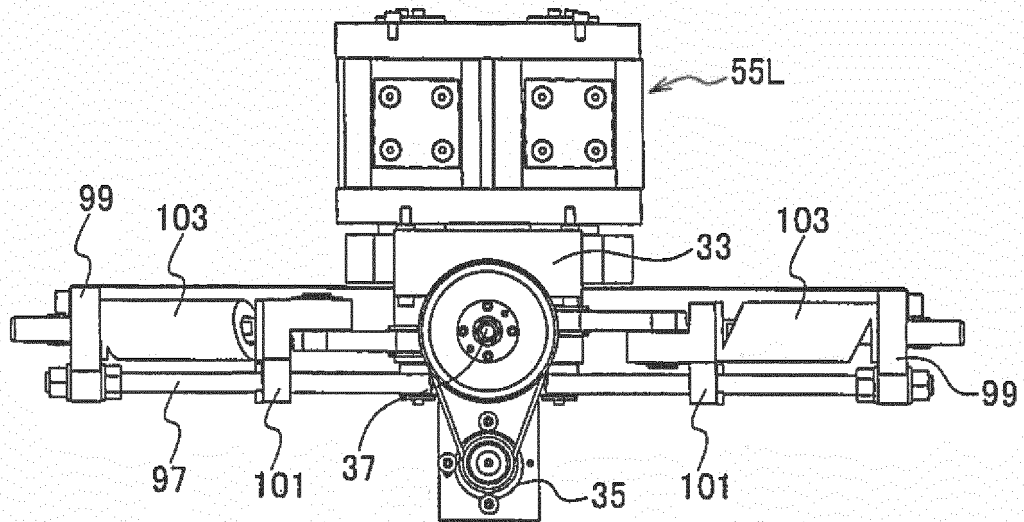


FIG. 13

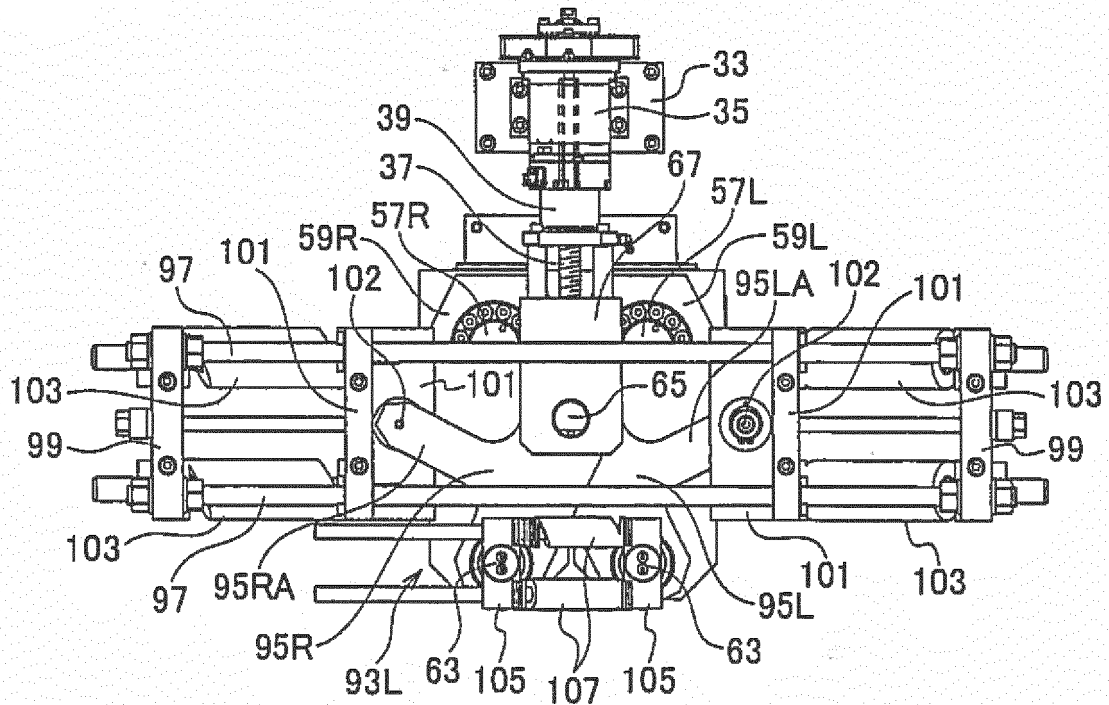


FIG. 14

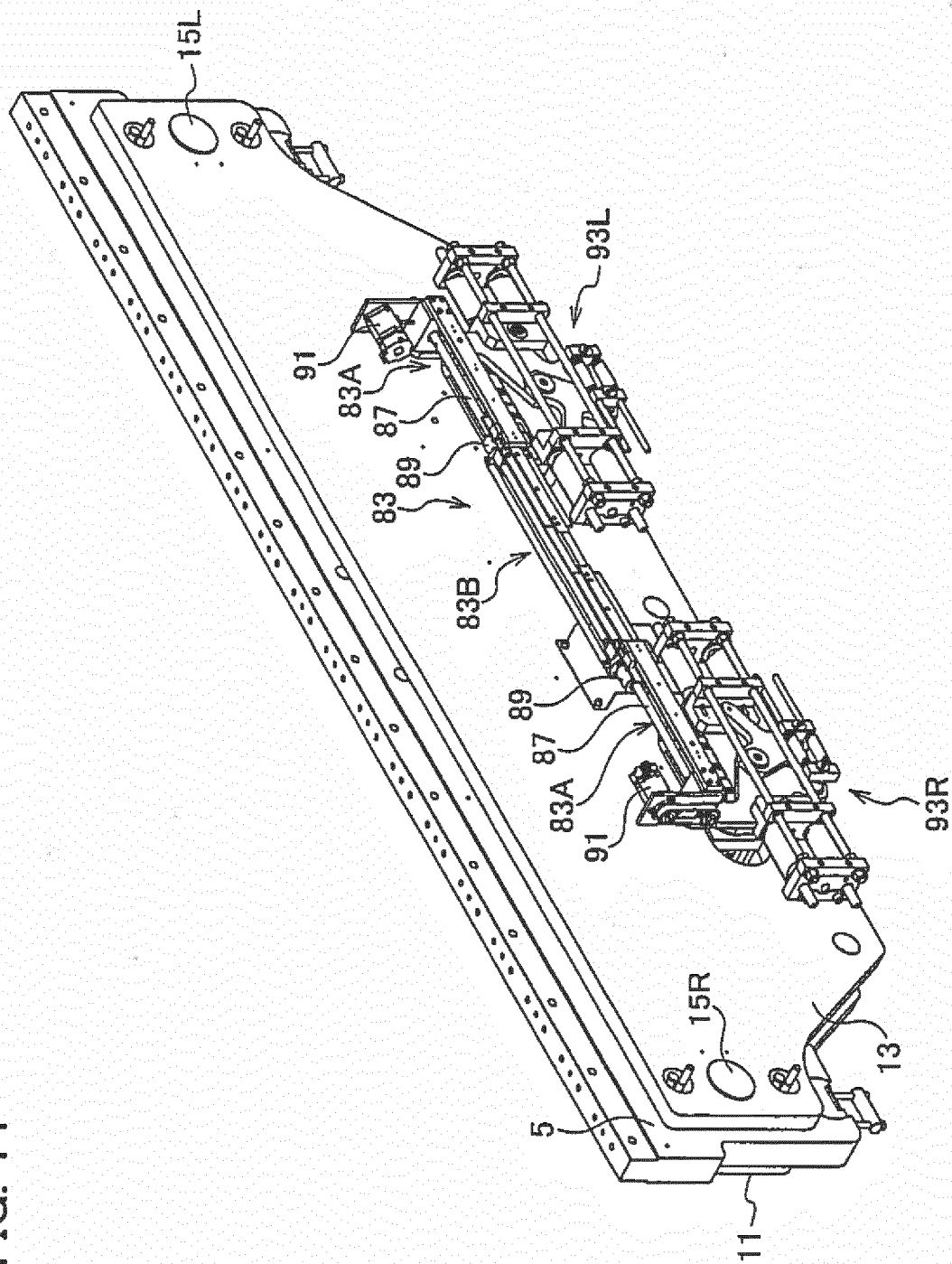


FIG. 15

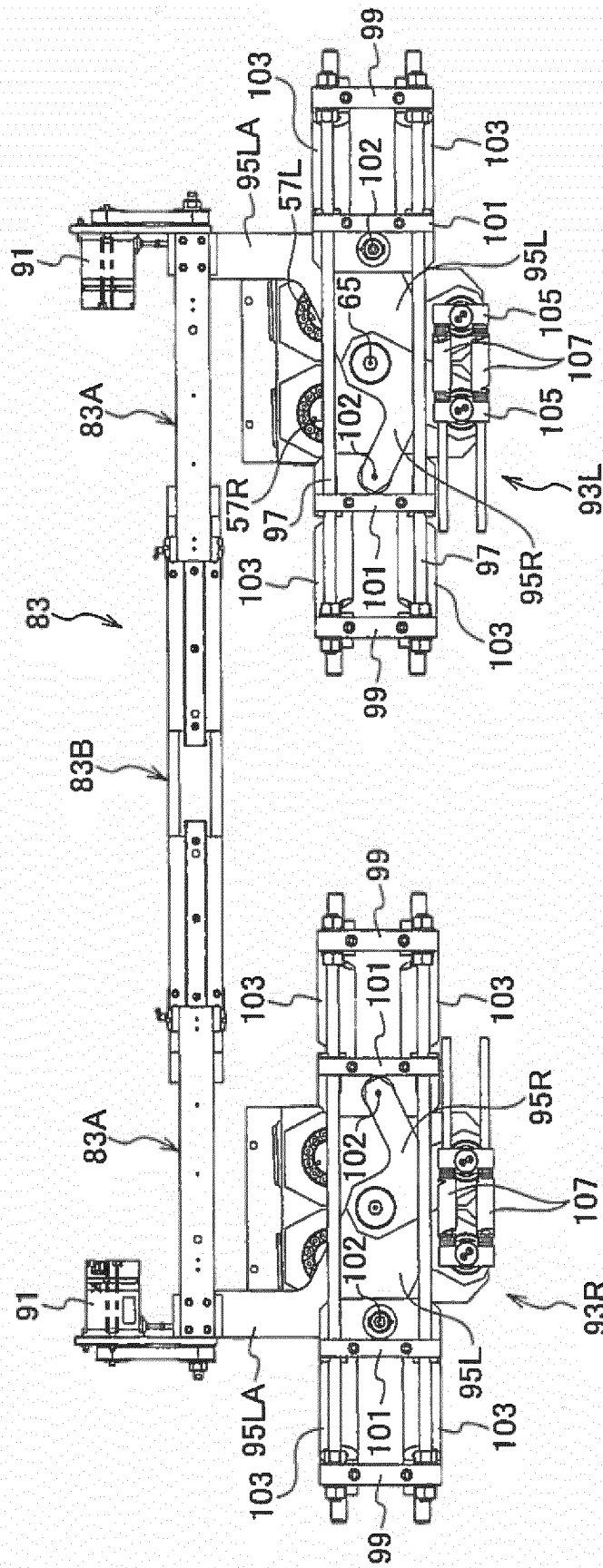


FIG. 16

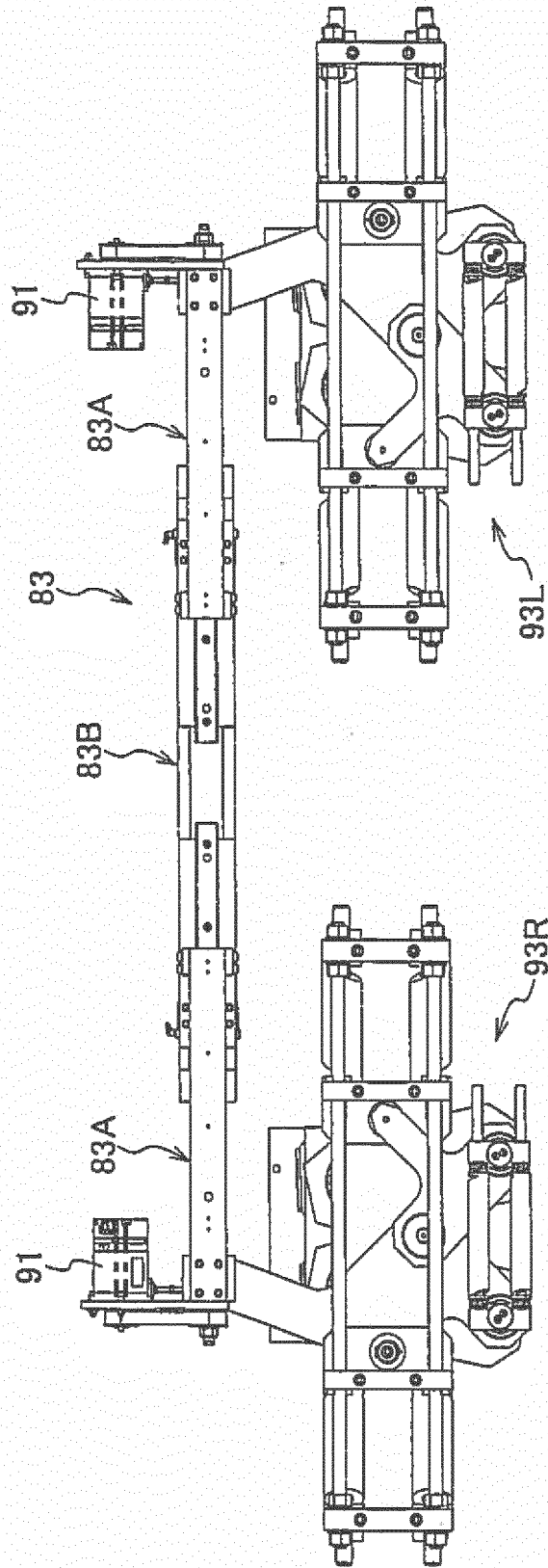


FIG. 17

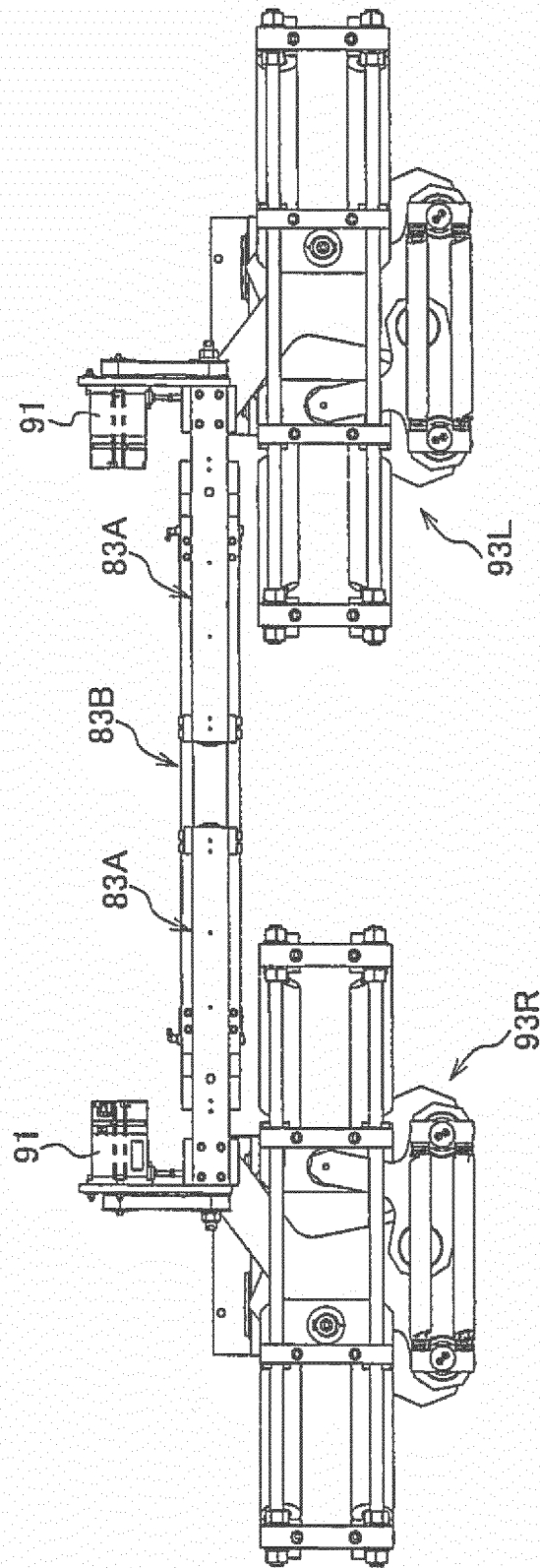


FIG. 18

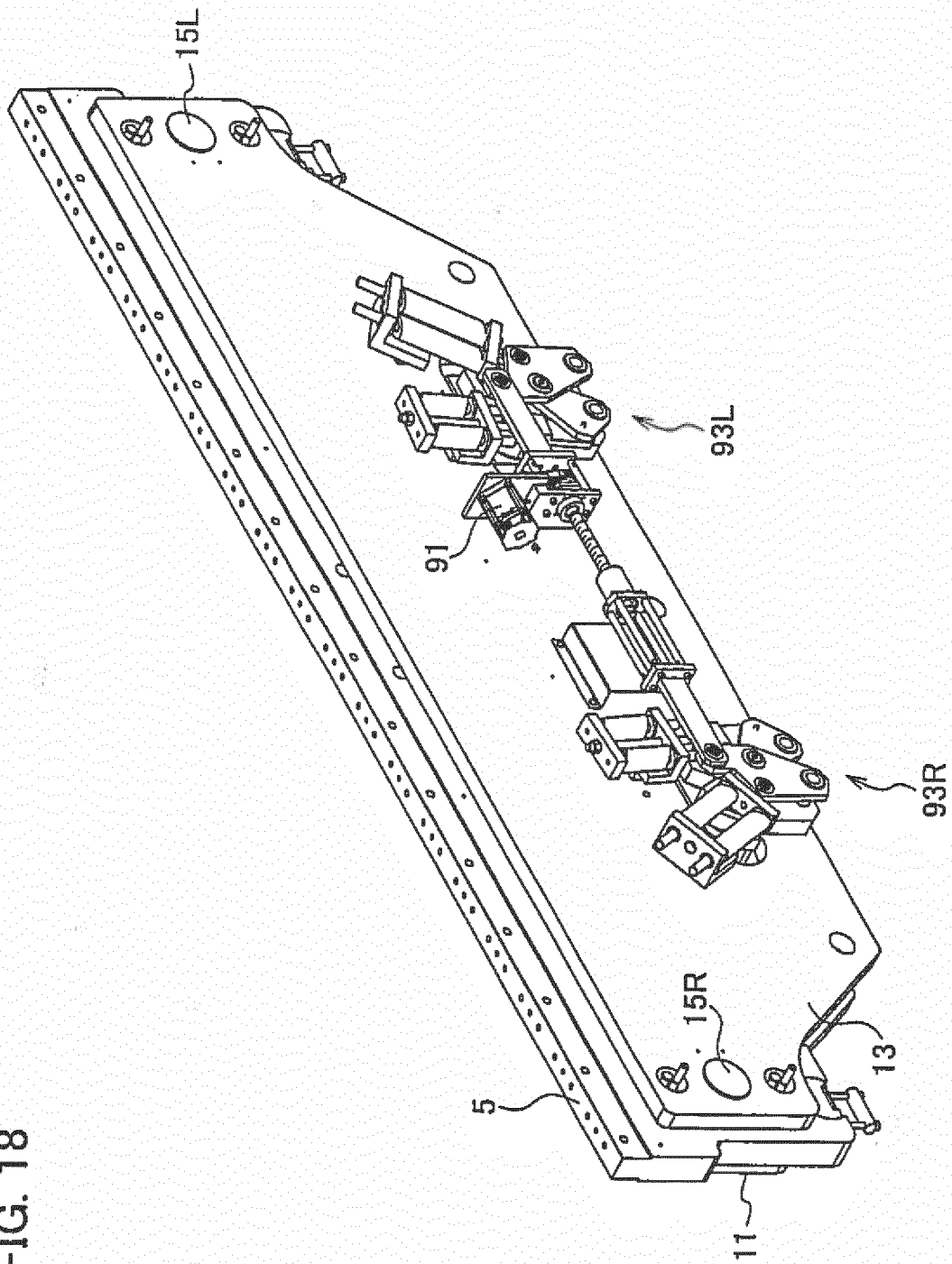
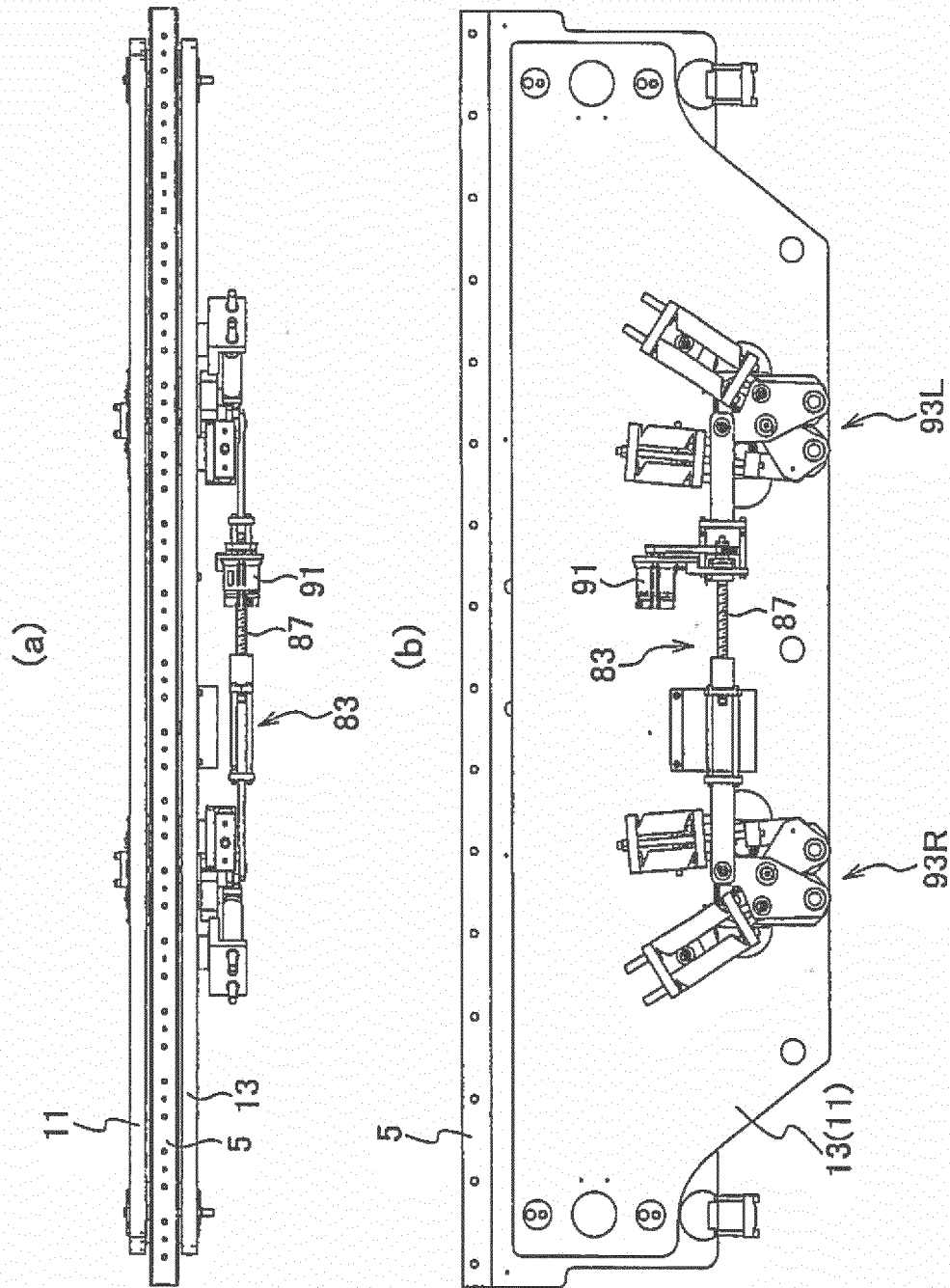


FIG. 19



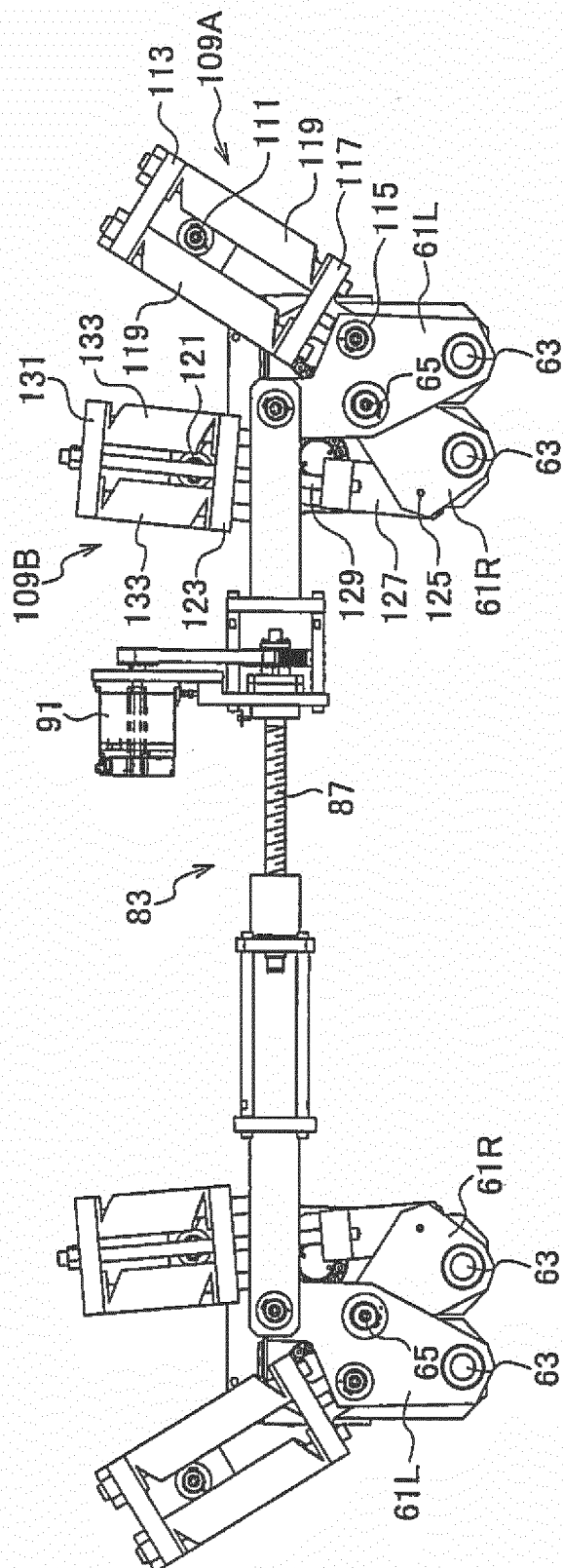
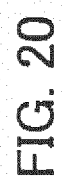
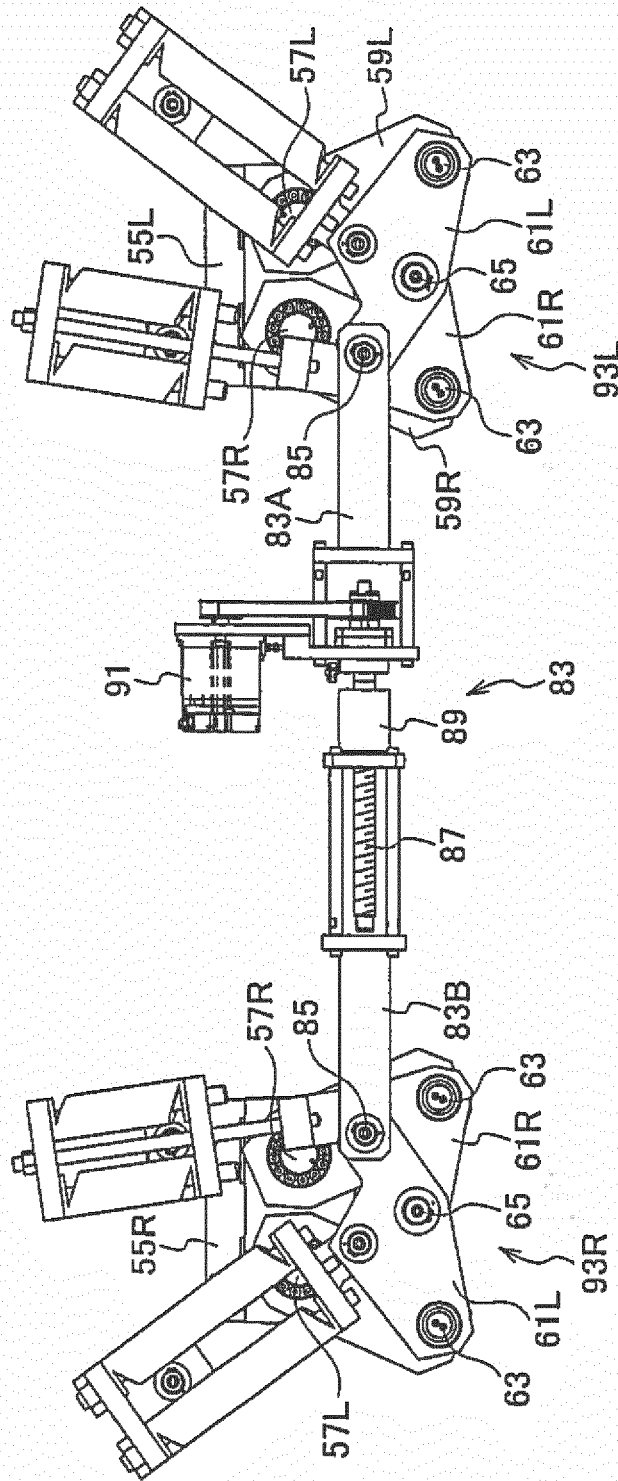


FIG. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/008581

A. CLASSIFICATION OF SUBJECT MATTER

B21D5/02(2006.01)i, B30B15/24(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B21D5/02, B30B15/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
 Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2015-178131 A (Amada Holdings Co., Ltd.), 08 October 2015 (08.10.2015), paragraphs [0031] to [0184]; fig. 1 to 25 & WO 2015/129576 A1	1-2, 4, 6-7, 10, 18, 21 3, 5, 8-9, 11-17, 19-20
A	JP 8-103832 A (Murata Machinery Ltd.), 23 April 1996 (23.04.1996), paragraphs [0007] to [0016]; fig. 1 to 2 & US 5709125 A column 2, line 43 to column 5, line 19; fig. 1 to 2 & DE 19536727 A & CN 1126655 A	1-21
A	JP 8-129938 A (Chubu Electric Power Co., Inc.), 21 May 1996 (21.05.1996), paragraphs [0015] to [0025]; fig. 1 to 4 (Family: none)	1-21

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
29 March 2017 (29.03.17)Date of mailing of the international search report
11 April 2017 (11.04.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

- JP 2000343127 A [0006]
- JP 2015178131 A [0006]