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**Chu et al.**

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(54) **APPARATUS AND METHOD FOR ACCURATE CARTON FORMATION**

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*B31B 50/788*; *B31B 2105/002*; *B31B 2120/30*;  
*B31B 50/07*; *B31B 50/066*;  
*B31B 50/06*; *B31B 50/006*; *B31B 50/044*;  
*B31B 2100/0022*; *B31B 2120/302*; *B31B 2110/35*

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USPC ... 493/309, 310, 315, 317, 162, 167, 52, 51,  
493/71, 34

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See application file for complete search history.

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*B31B 50/00* (2017.01)  
*B31B 50/04* (2017.01)  
*B31B 50/06* (2017.01)  
*B31B 50/07* (2017.01)  
*B31B 110/35* (2017.01)  
*B31B 100/00* (2017.01)  
*B31B 120/30* (2017.01)

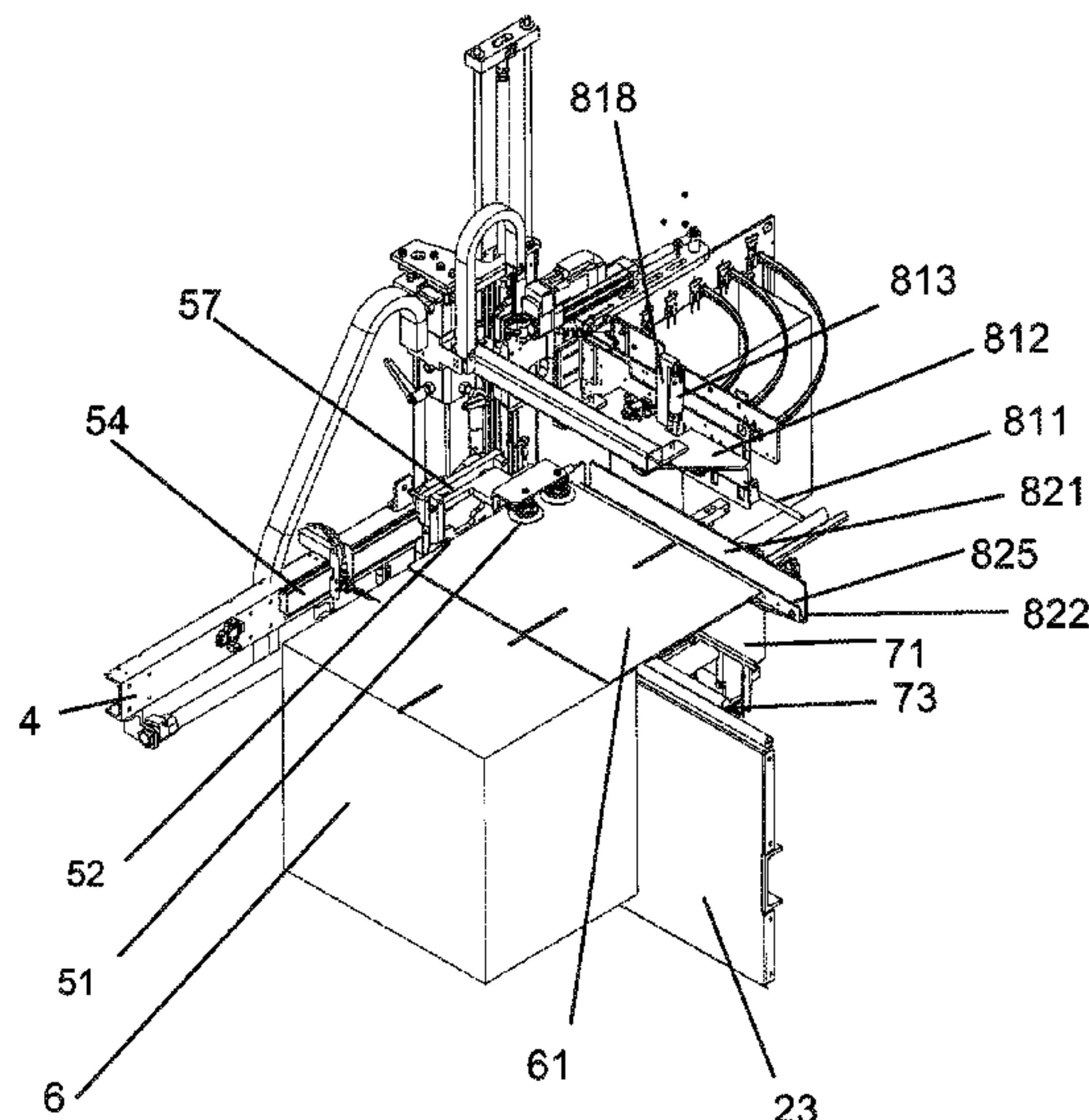
(52) **U.S. Cl.**

CPC ..... *B31B 50/784* (2017.08); *B31B 50/006* (2017.08); *B31B 50/044* (2017.08); *B31B 50/06* (2017.08); *B31B 50/066* (2017.08);

(57) **ABSTRACT**

A carton forming machine includes a carton blank push up device that receives a substantially horizontal folded carton blank and reorients the folded carton blank from the substantially horizontal orientation to an upright orientation below and in a first direction alignment with a carton opening mechanism. A carton blank positioning apparatus shifts the upright folded carton blank in a second direction, transverse to the first direction, below the carton opening mechanism to define a second direction position of the upright carton blank below the carton opening mechanism before the carton opening mechanism engages the upright carton blank for opening of the upright carton blank.

**12 Claims, 25 Drawing Sheets**



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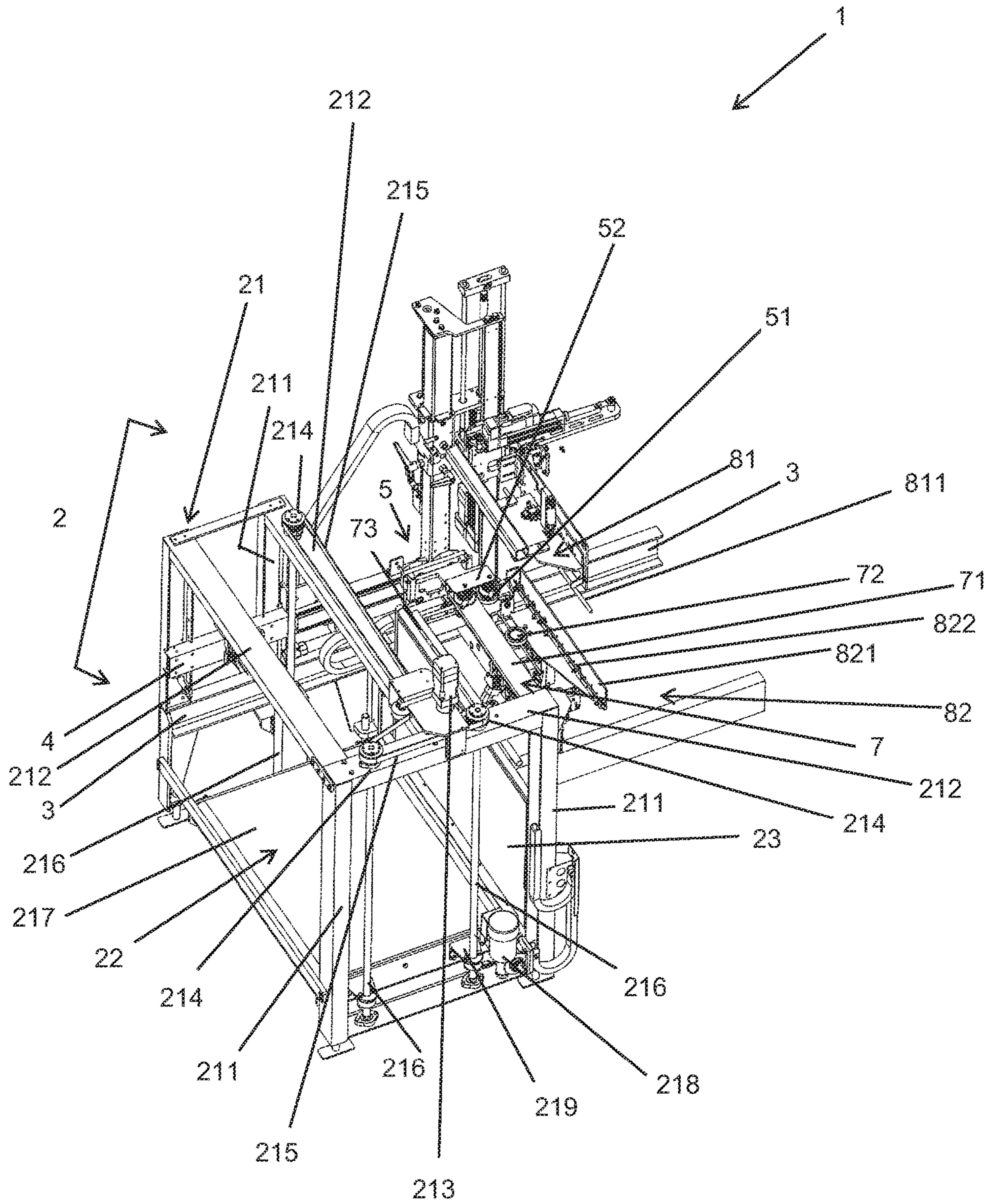


Fig. 1

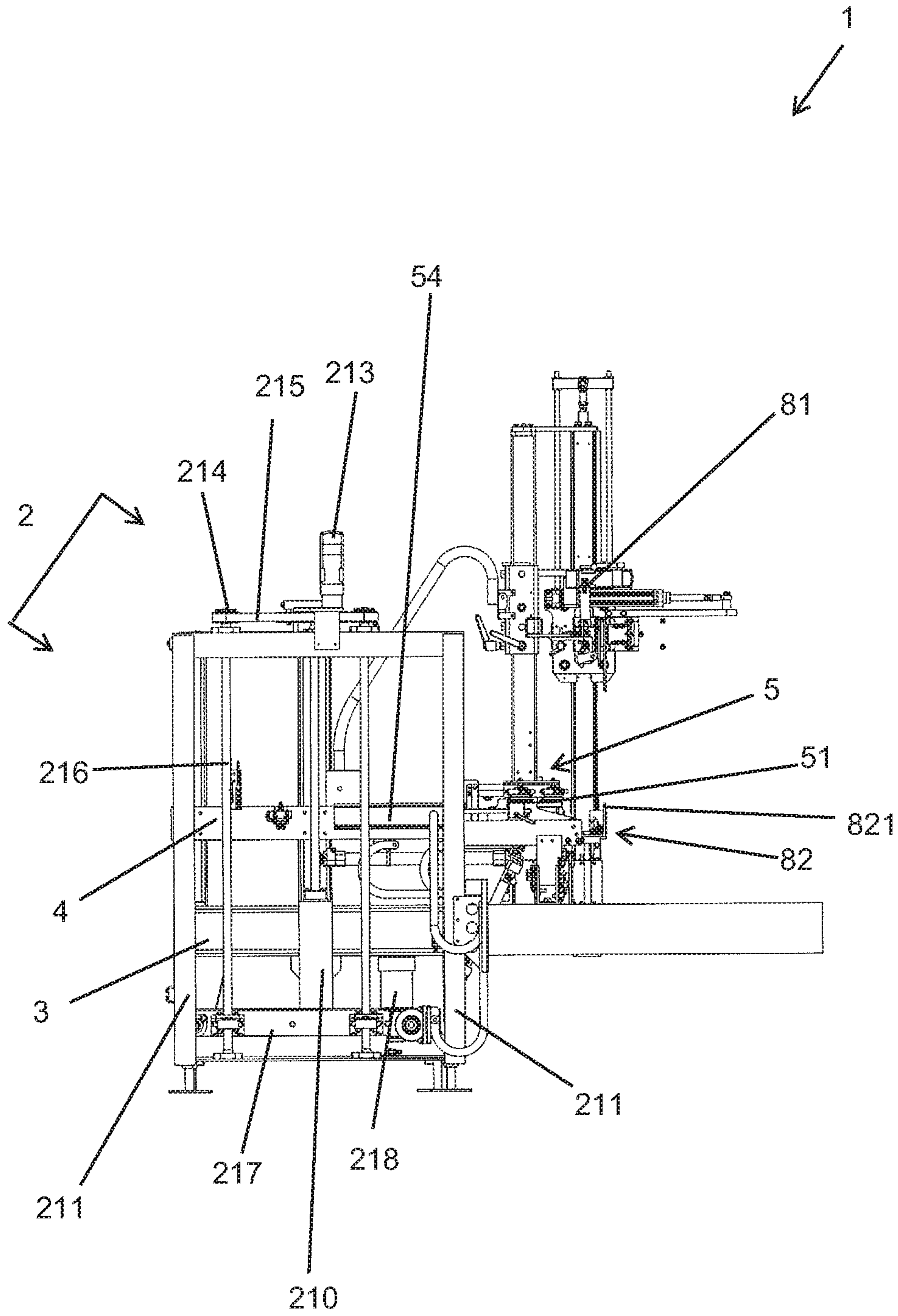


Fig. 2

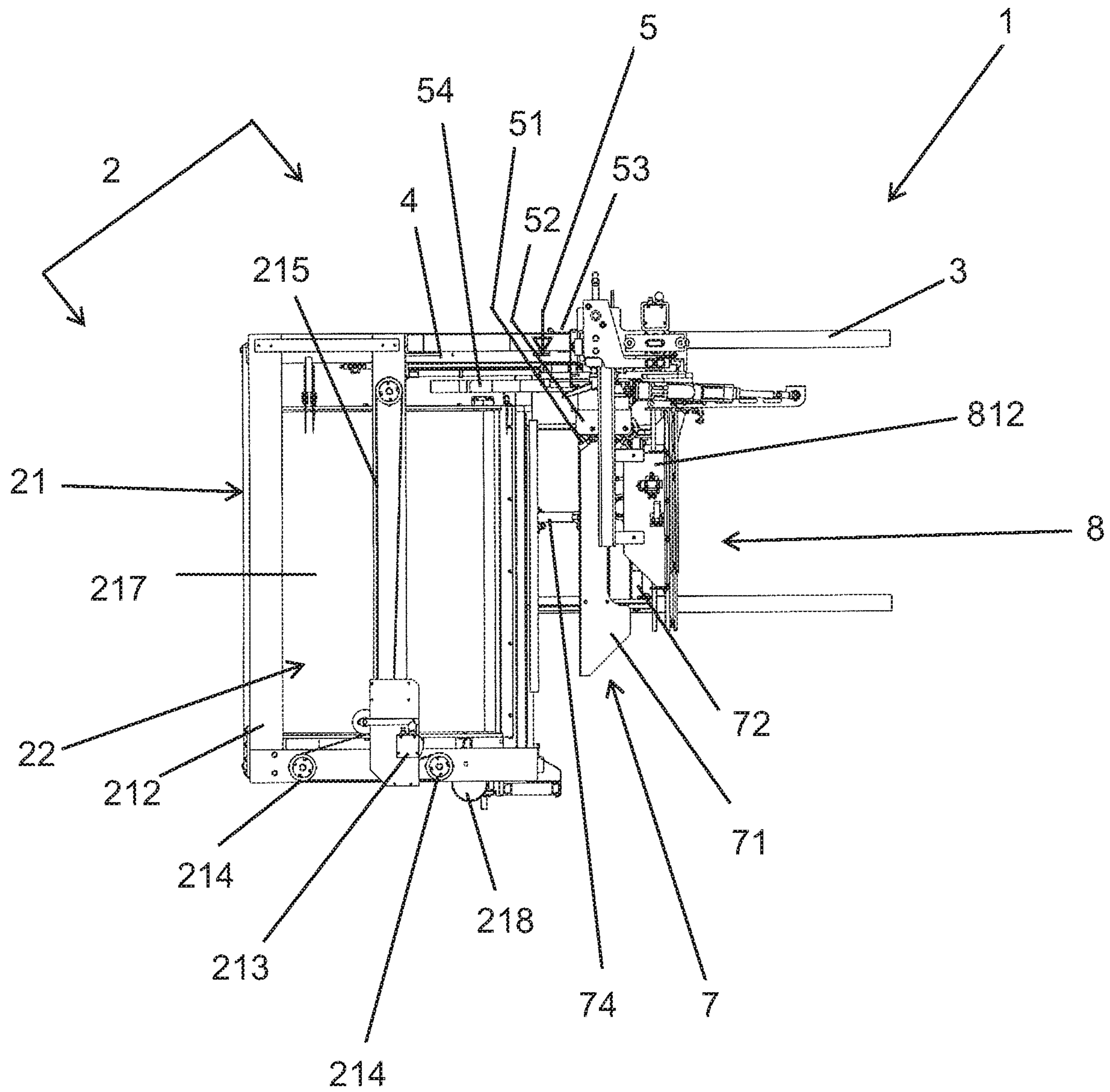


Fig. 3



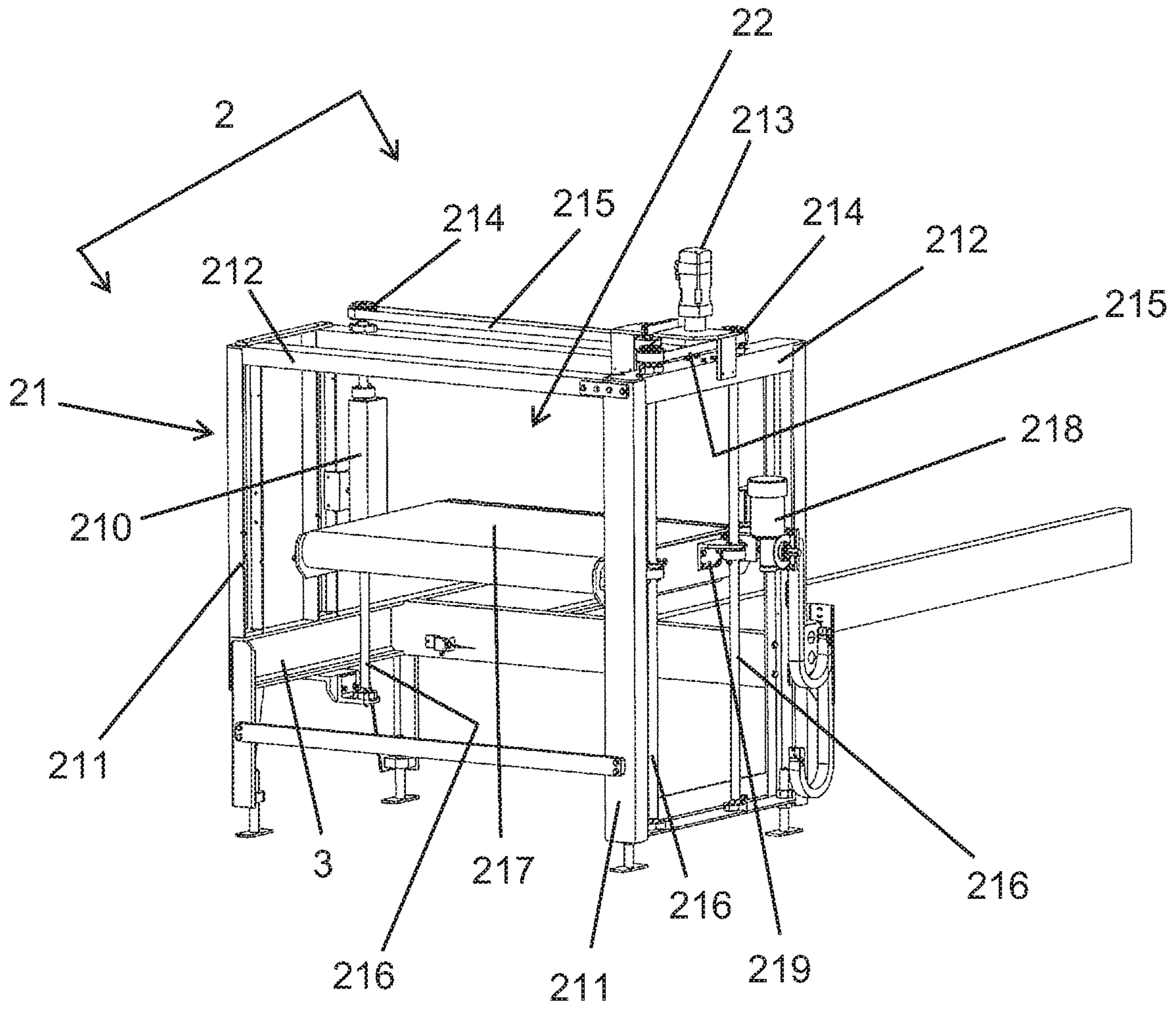


Fig. 4

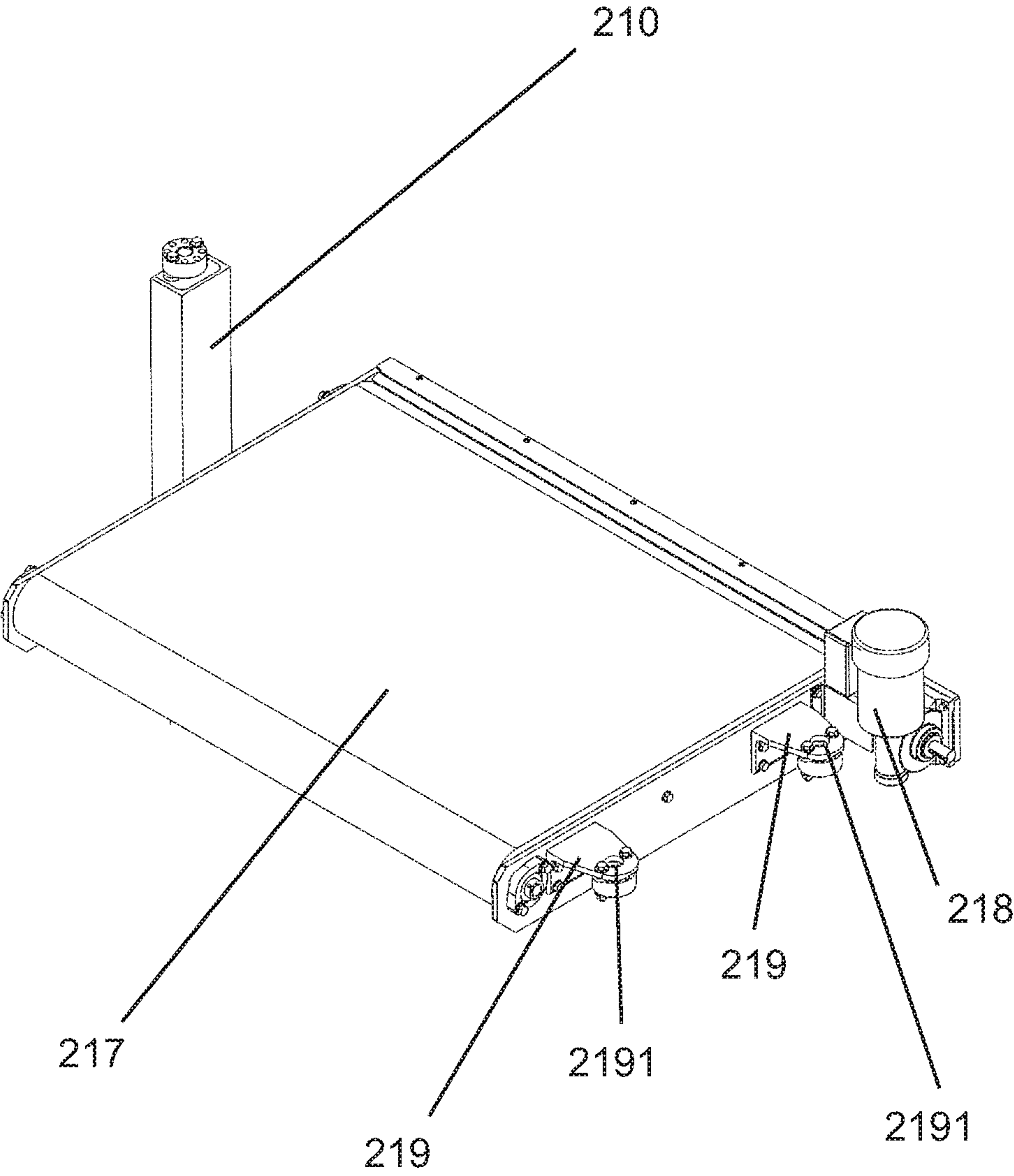


Fig. 5

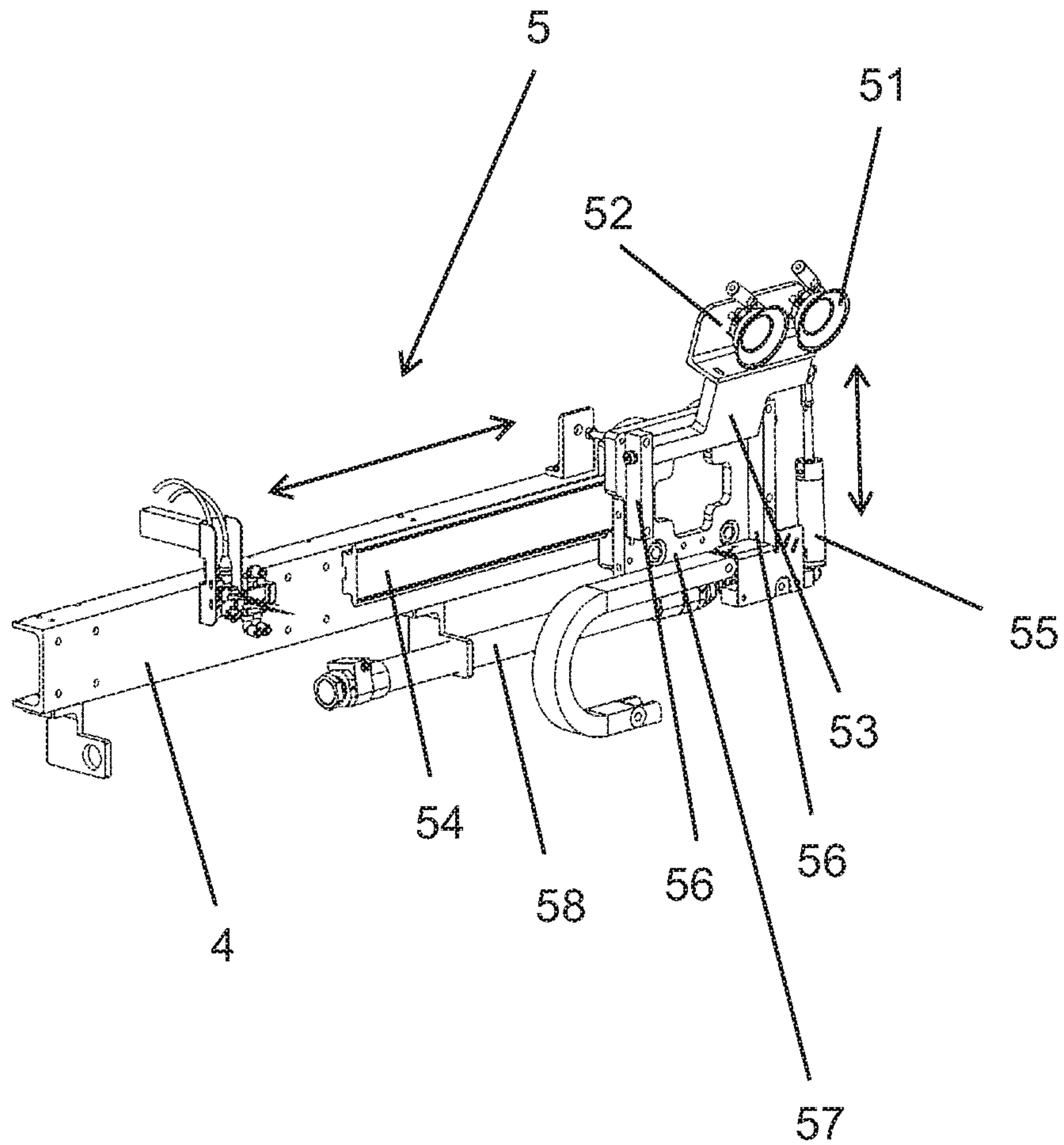


Fig. 6



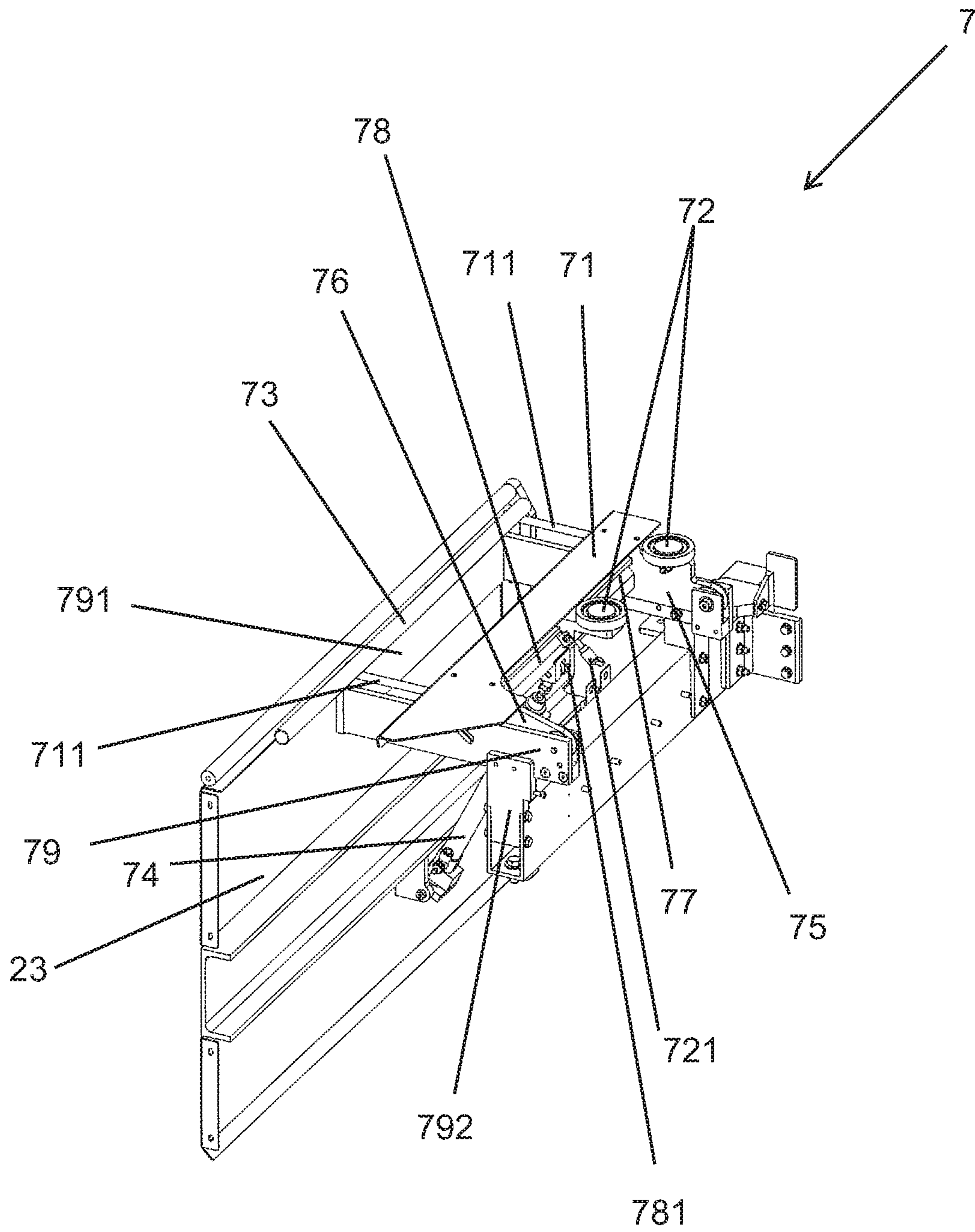


Fig. 7

Fig. 8A

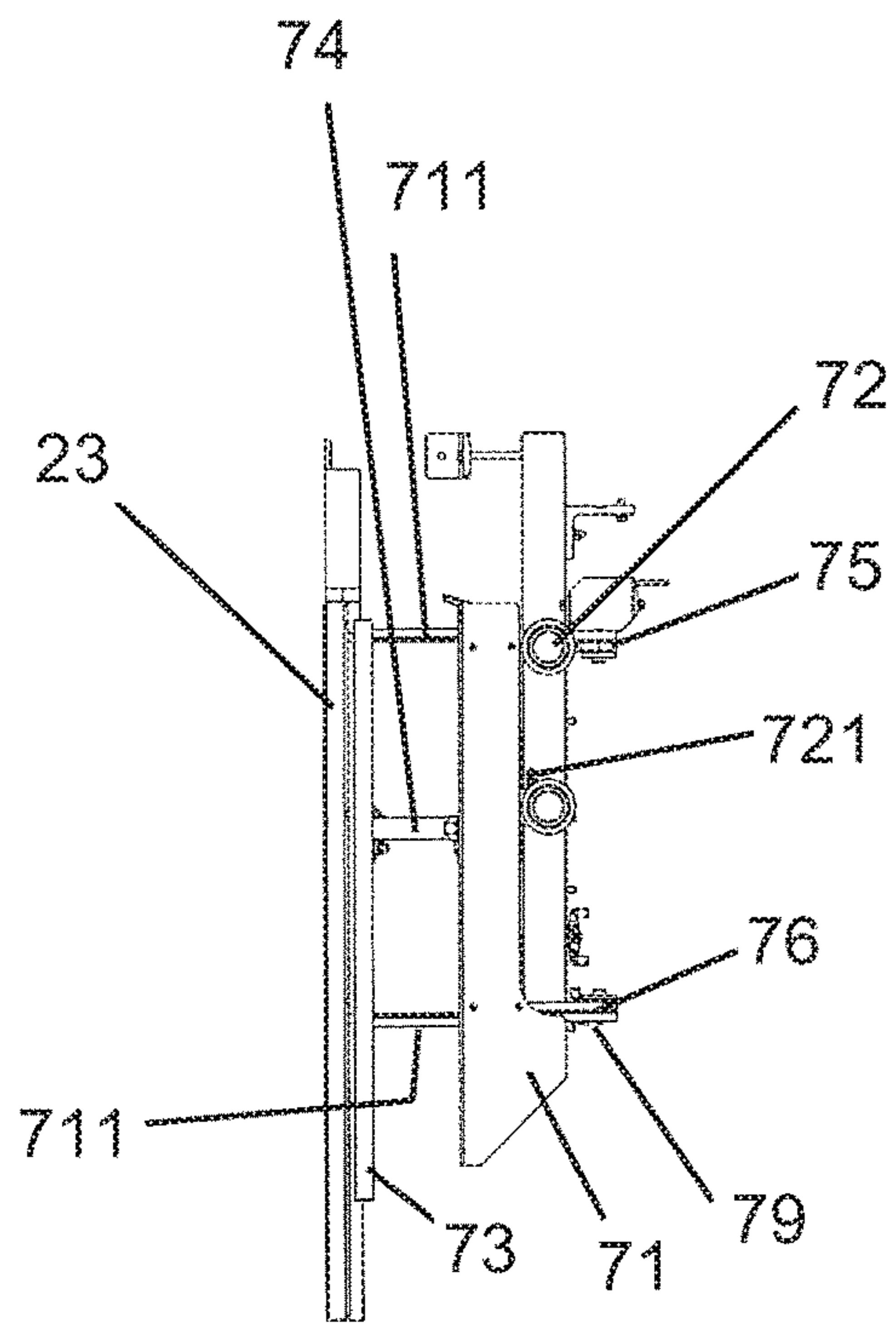


Fig. 8B

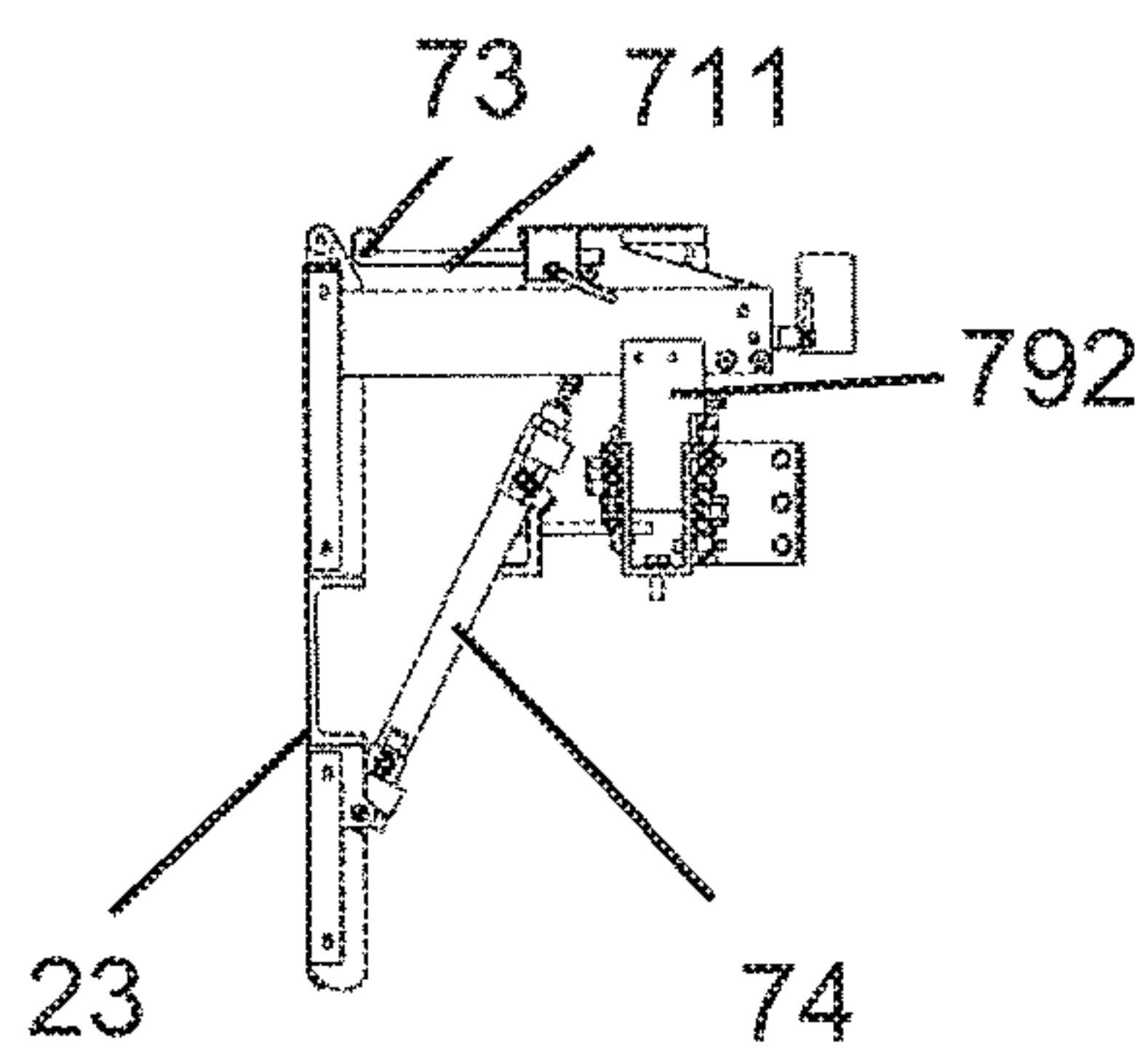
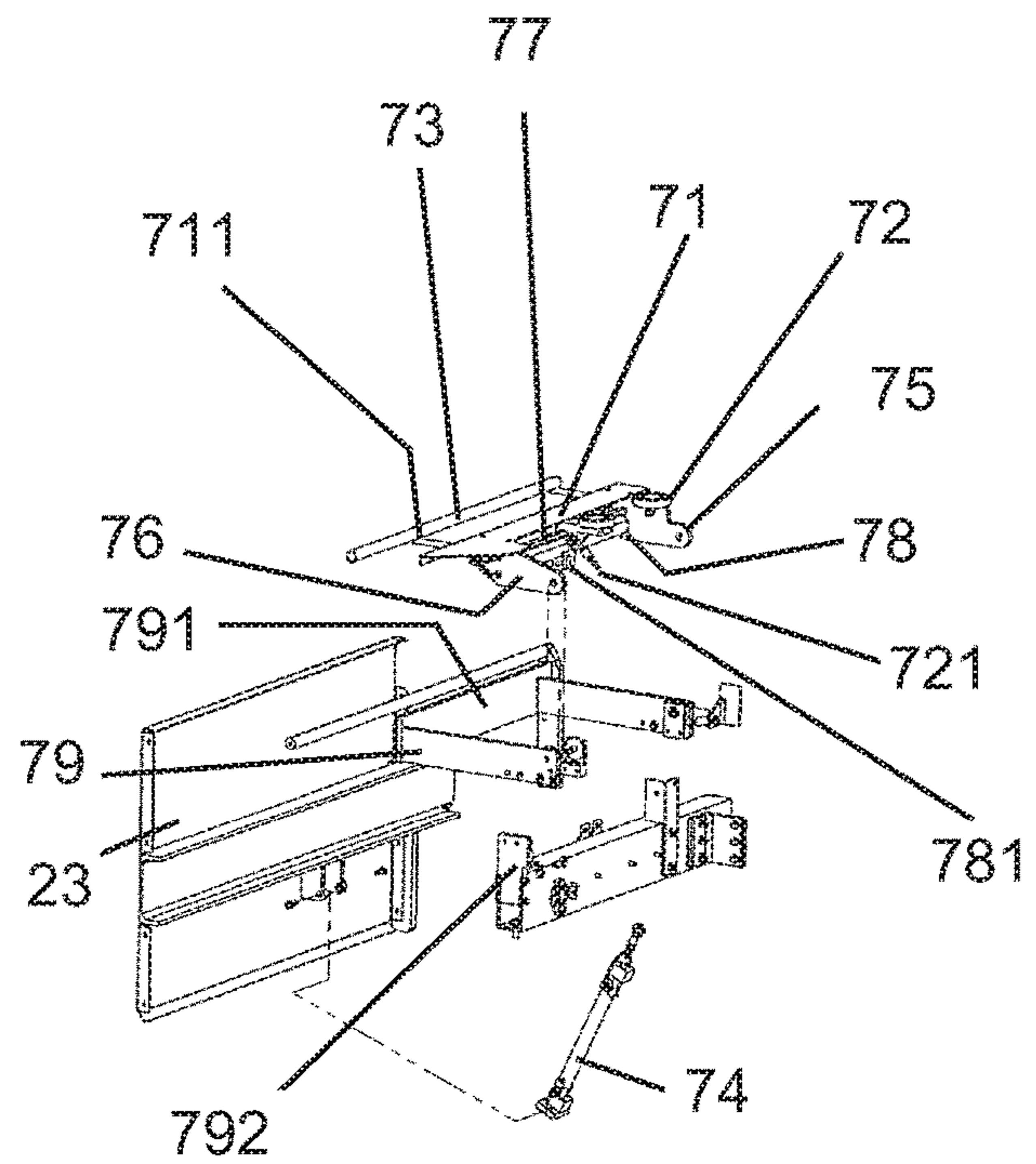


Fig. 8C

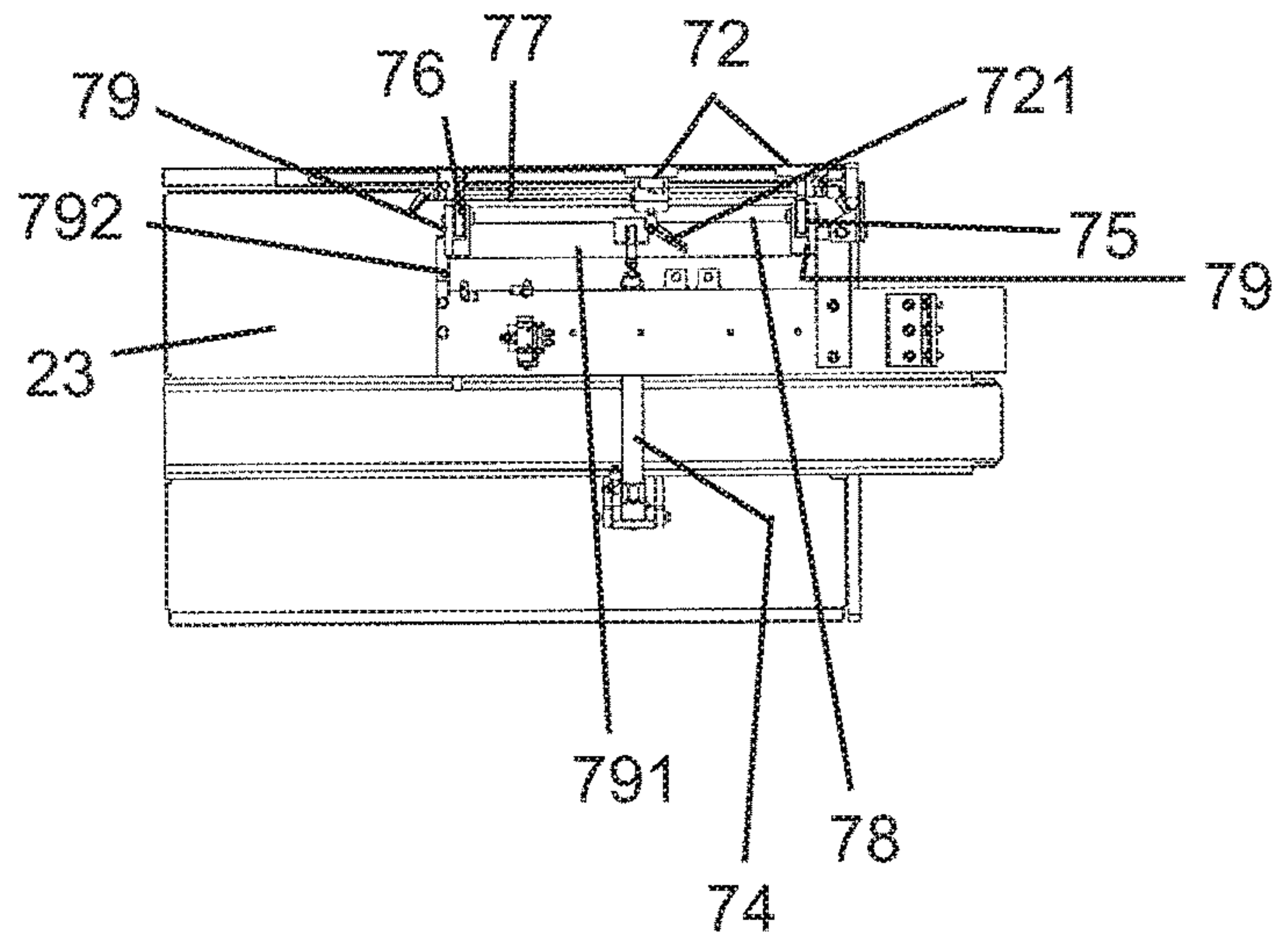


Fig. 8D

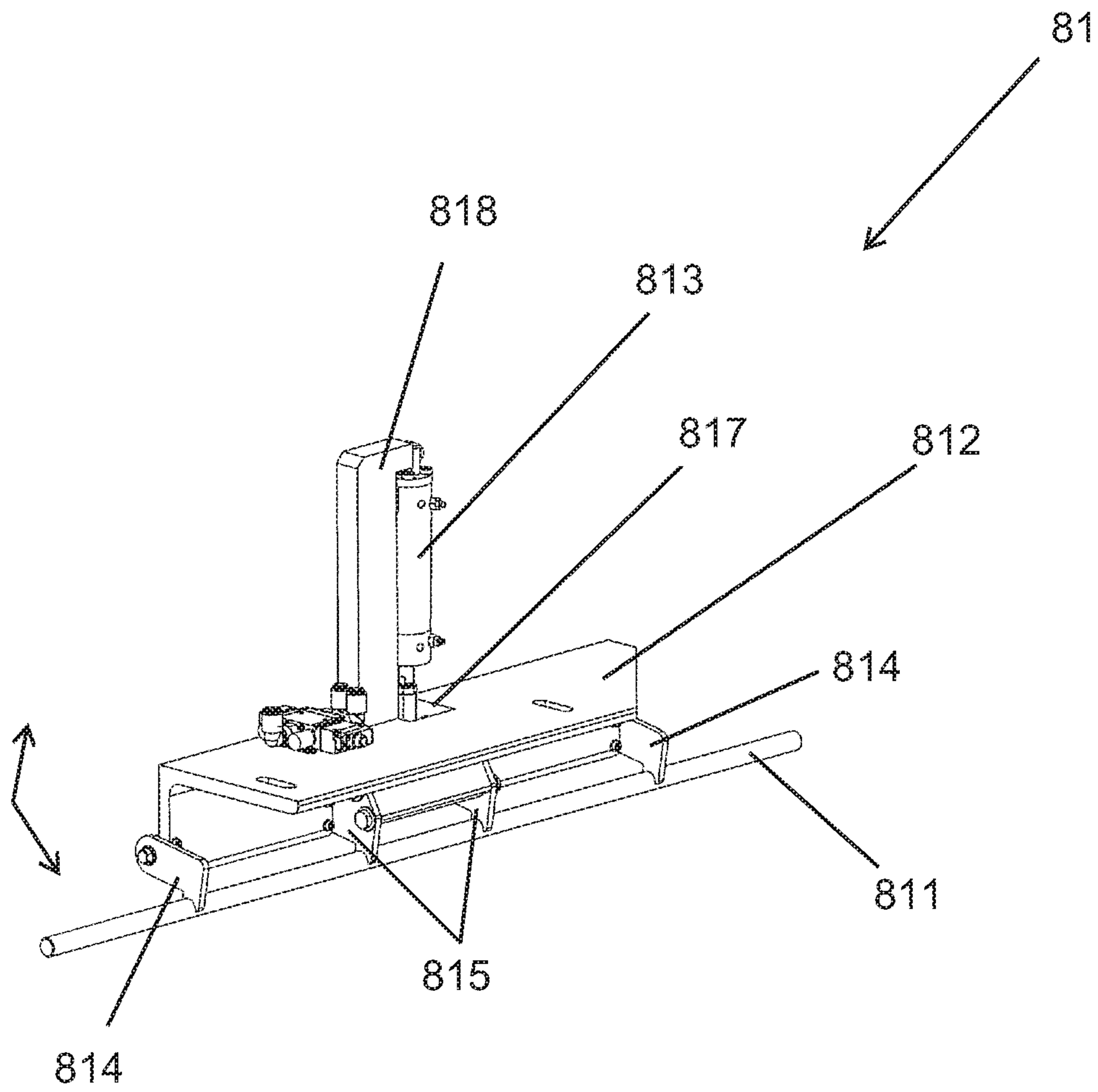


Fig. 9



Fig. 10A

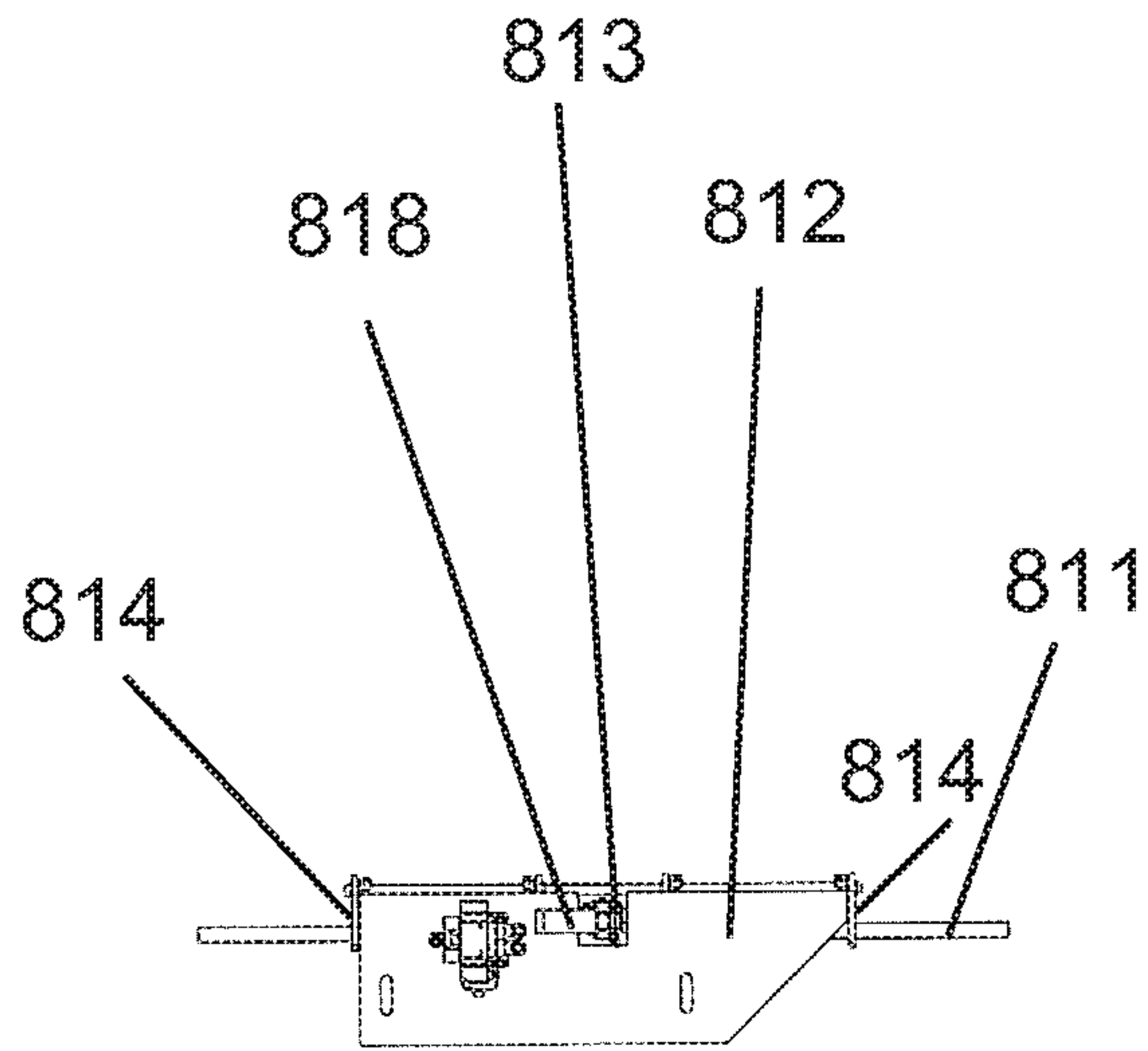


Fig. 10B

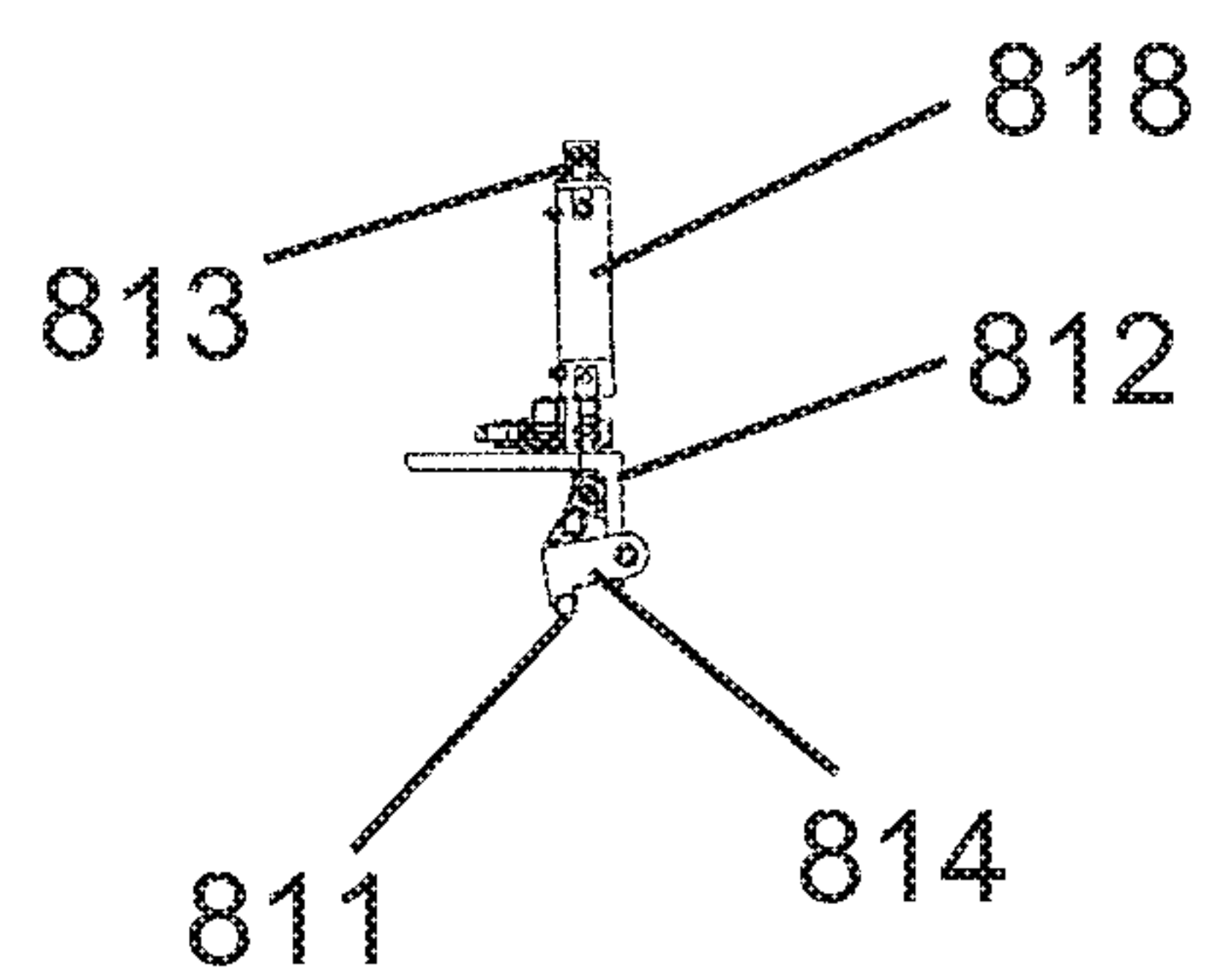
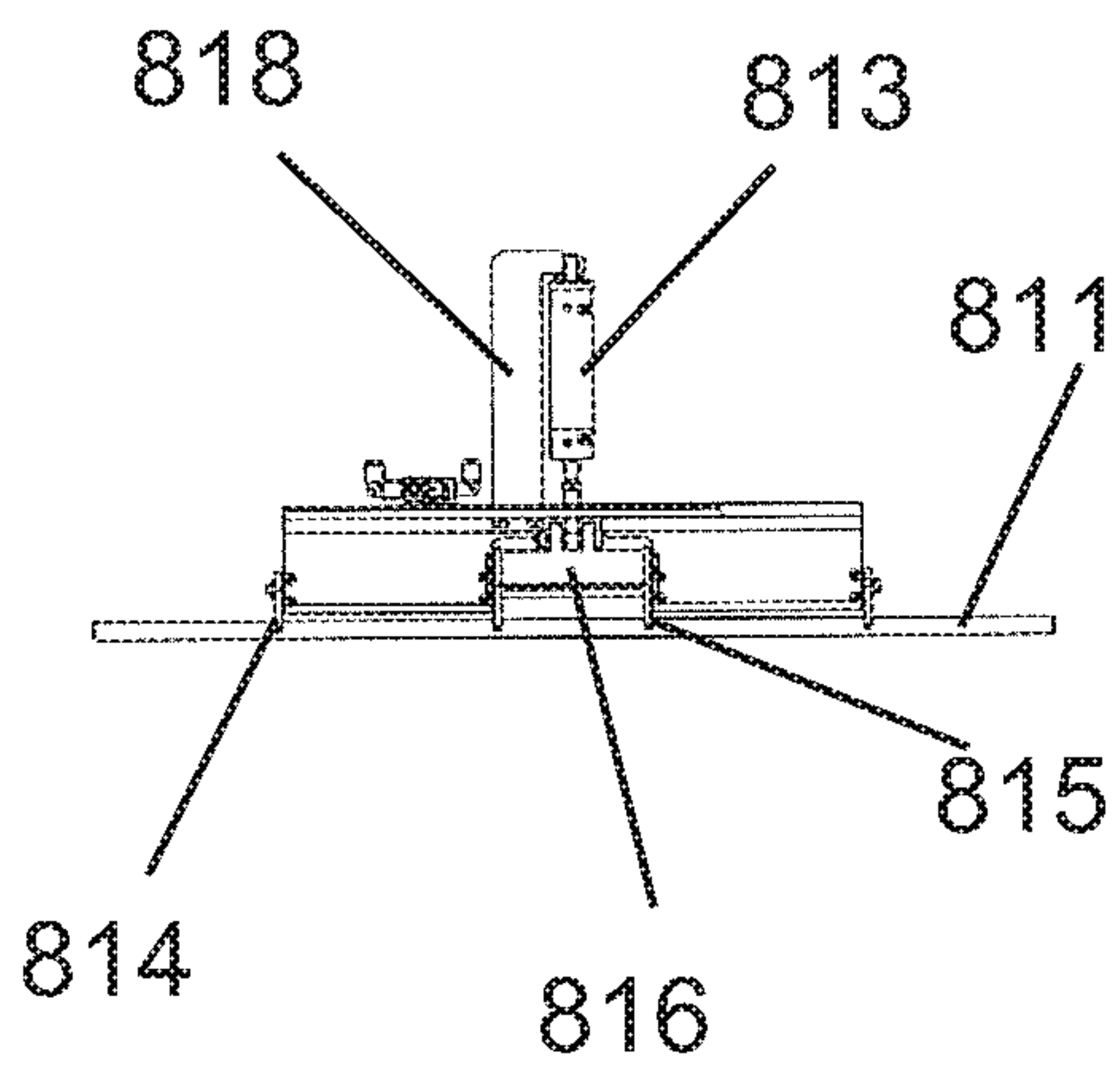
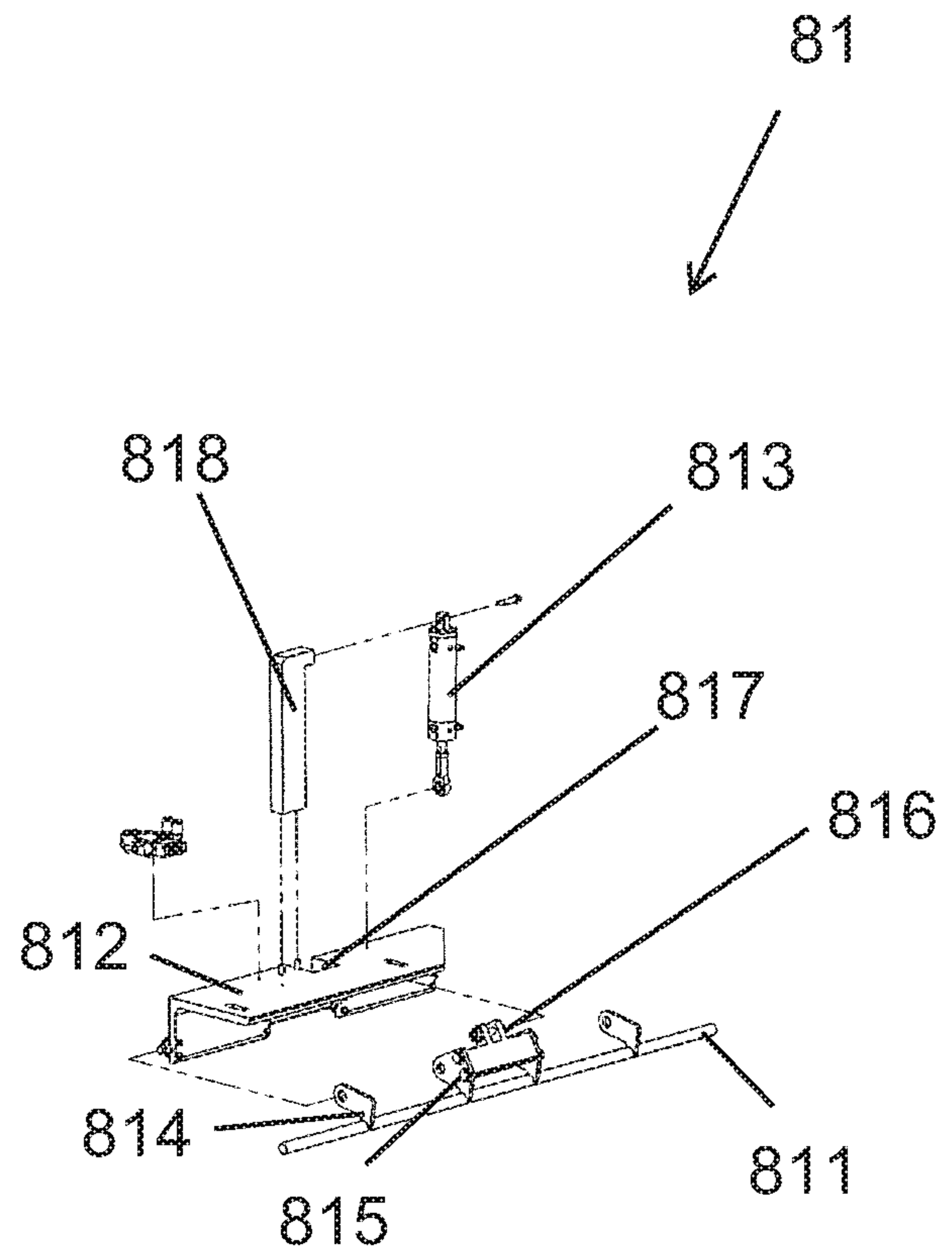


Fig. 10C

Fig. 10D

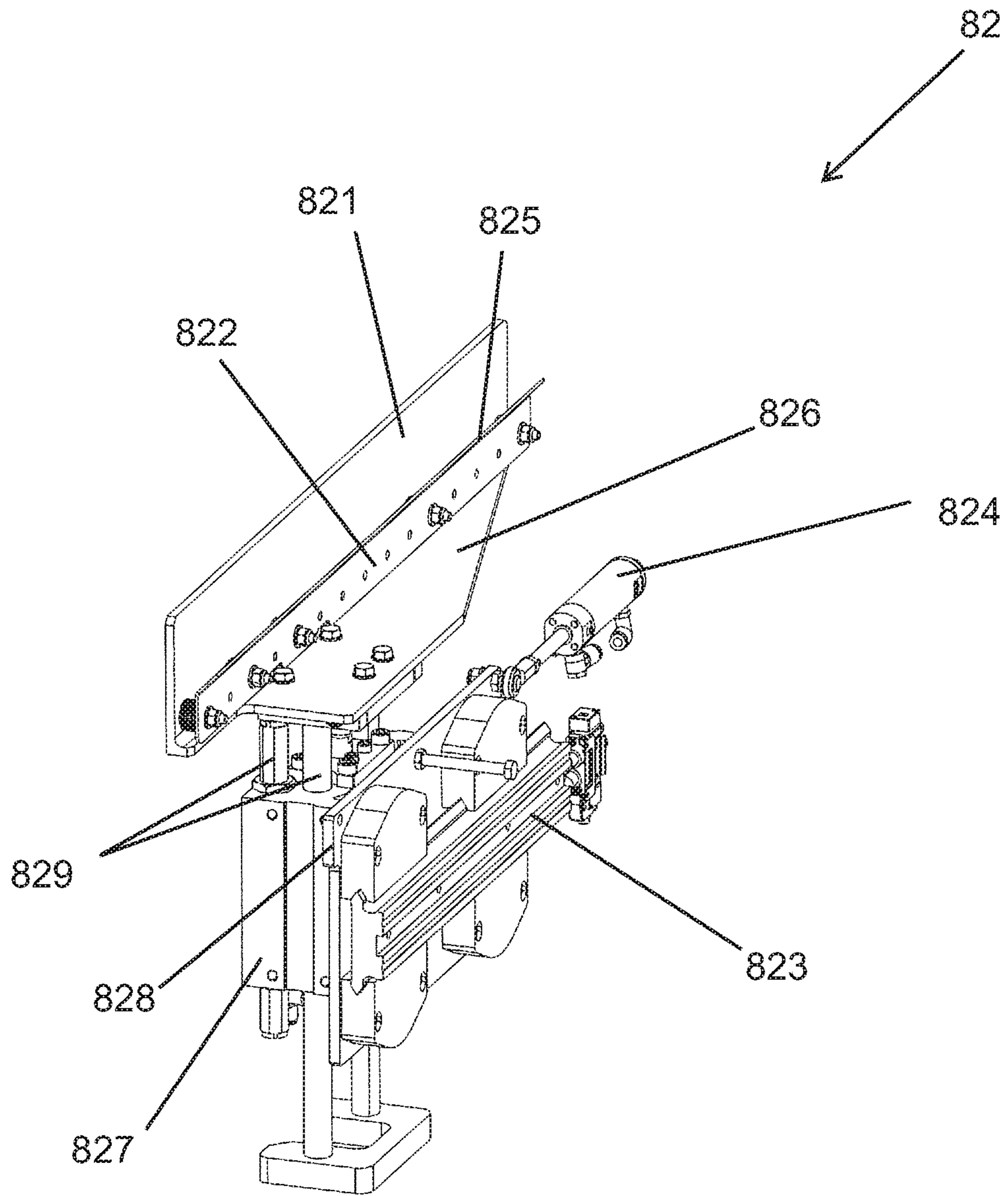


Fig. 11

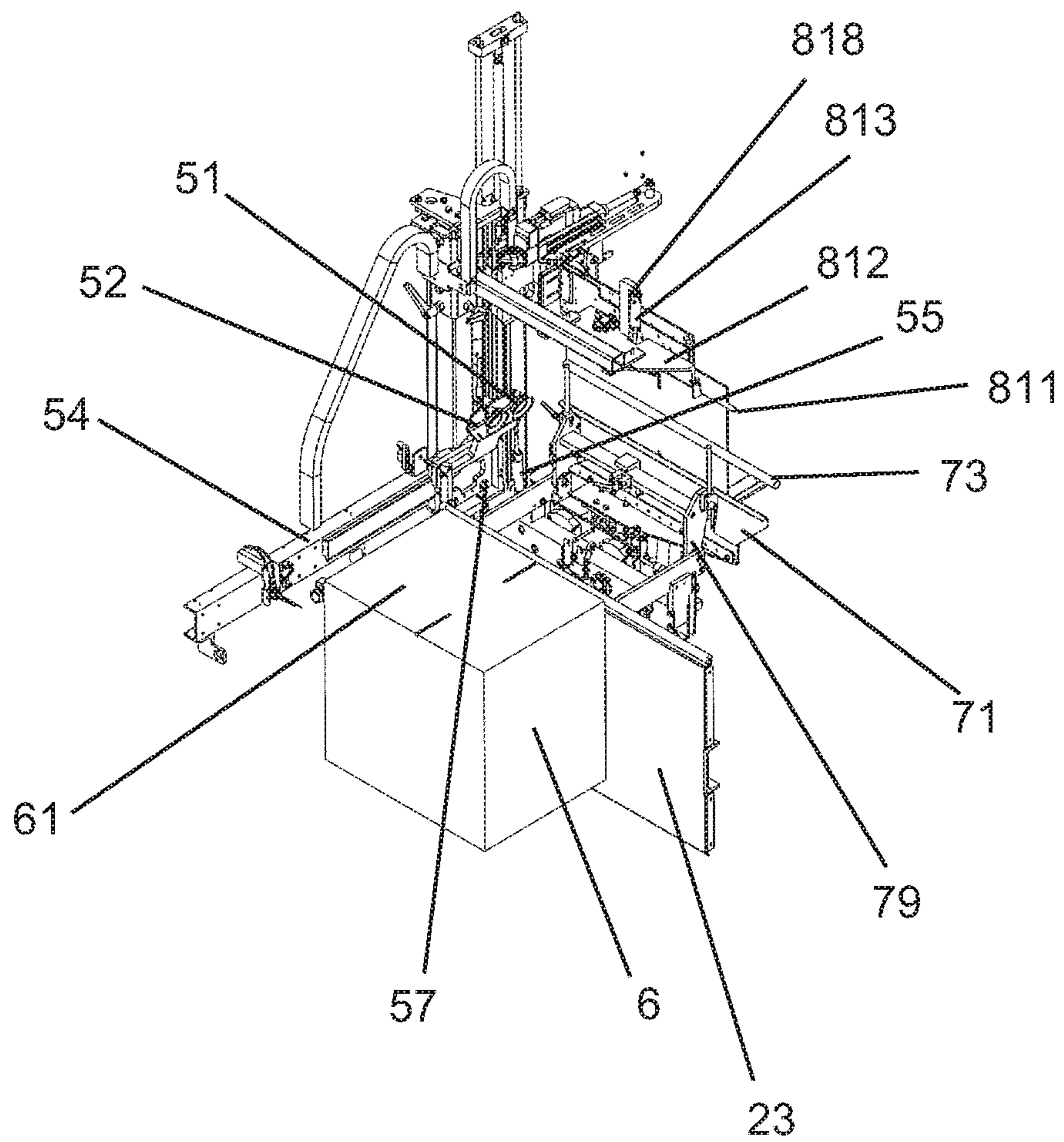


Fig. 12



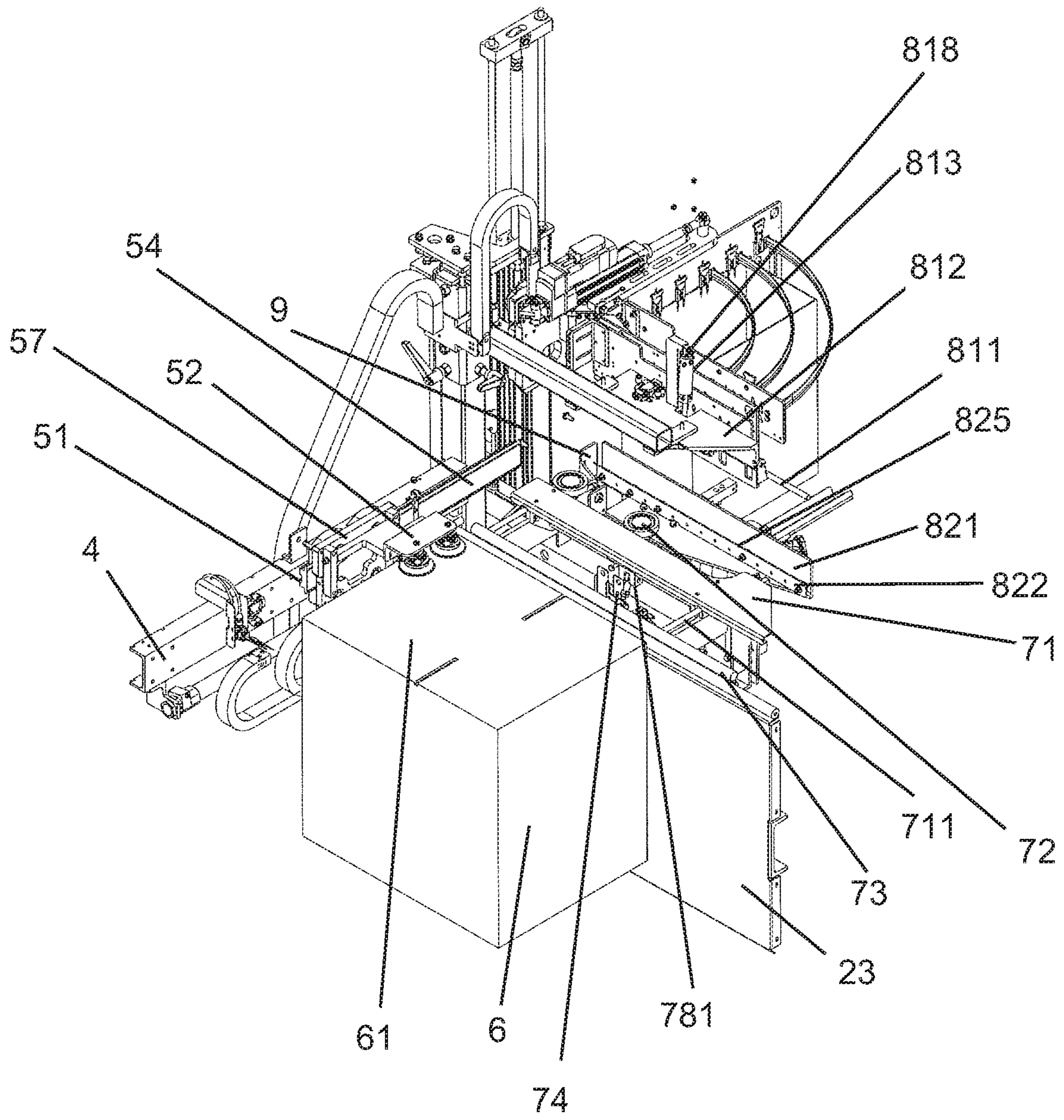


Fig. 13

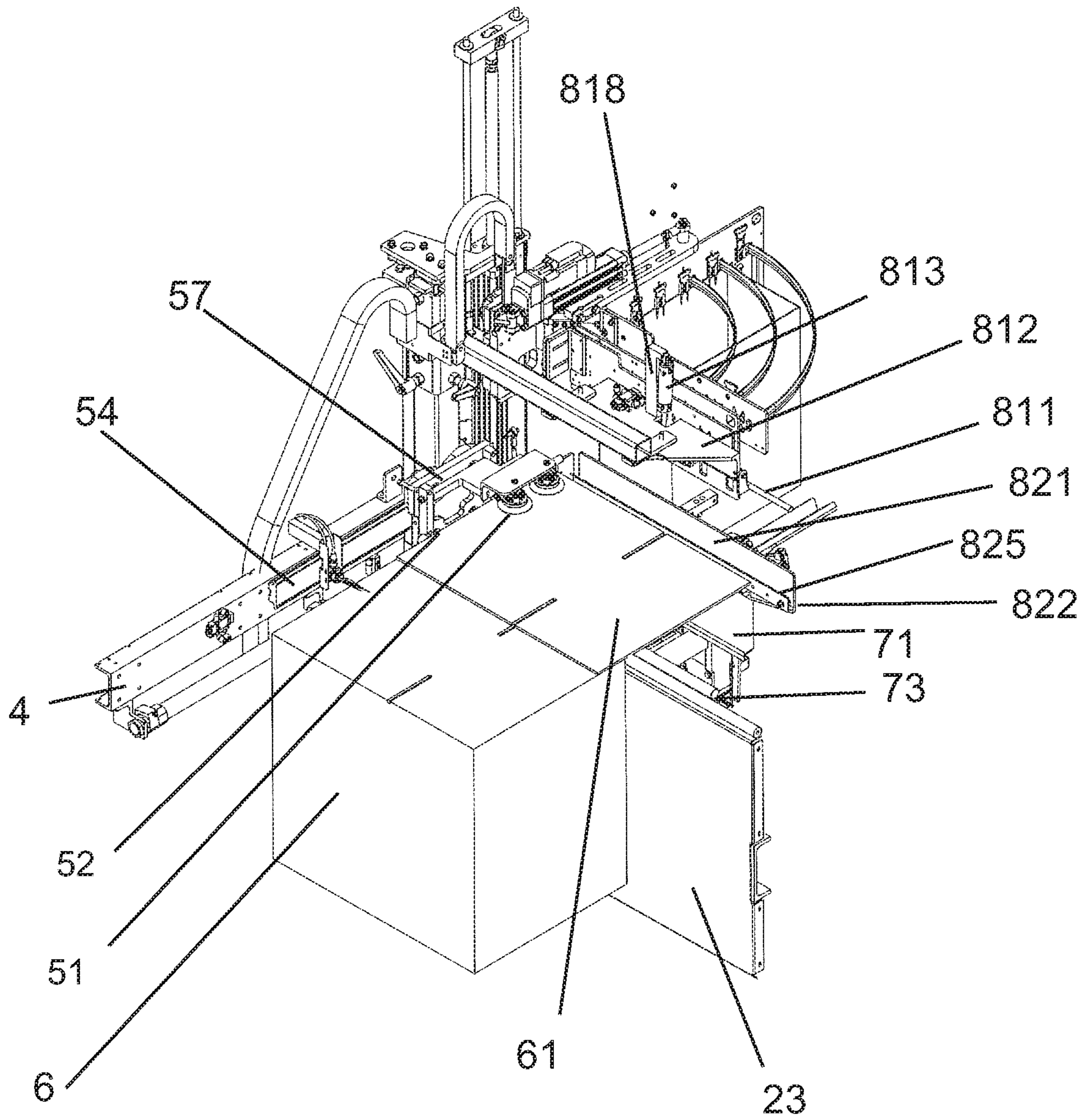


Fig. 14A



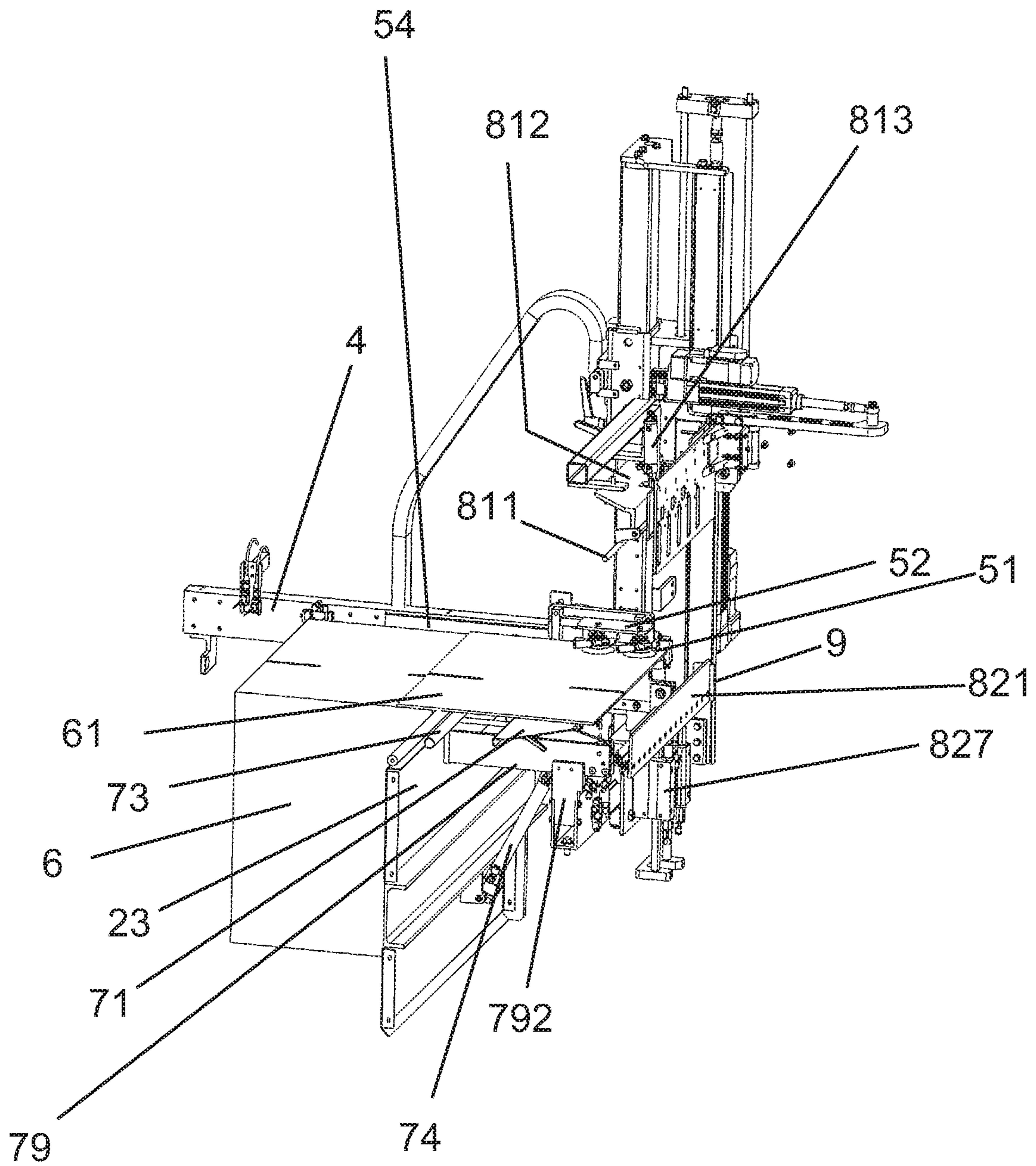


Fig. 14B



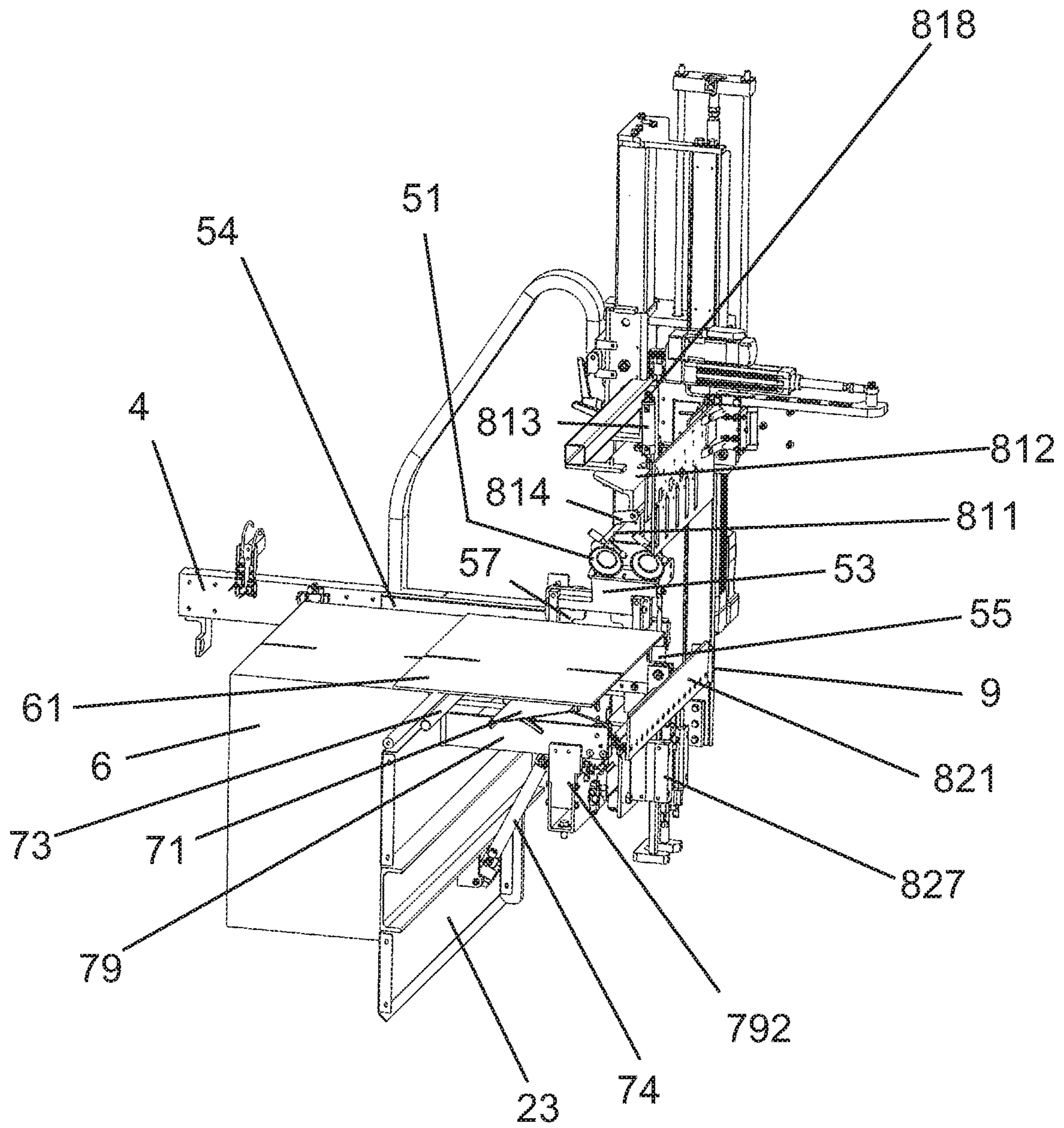


Fig. 15A

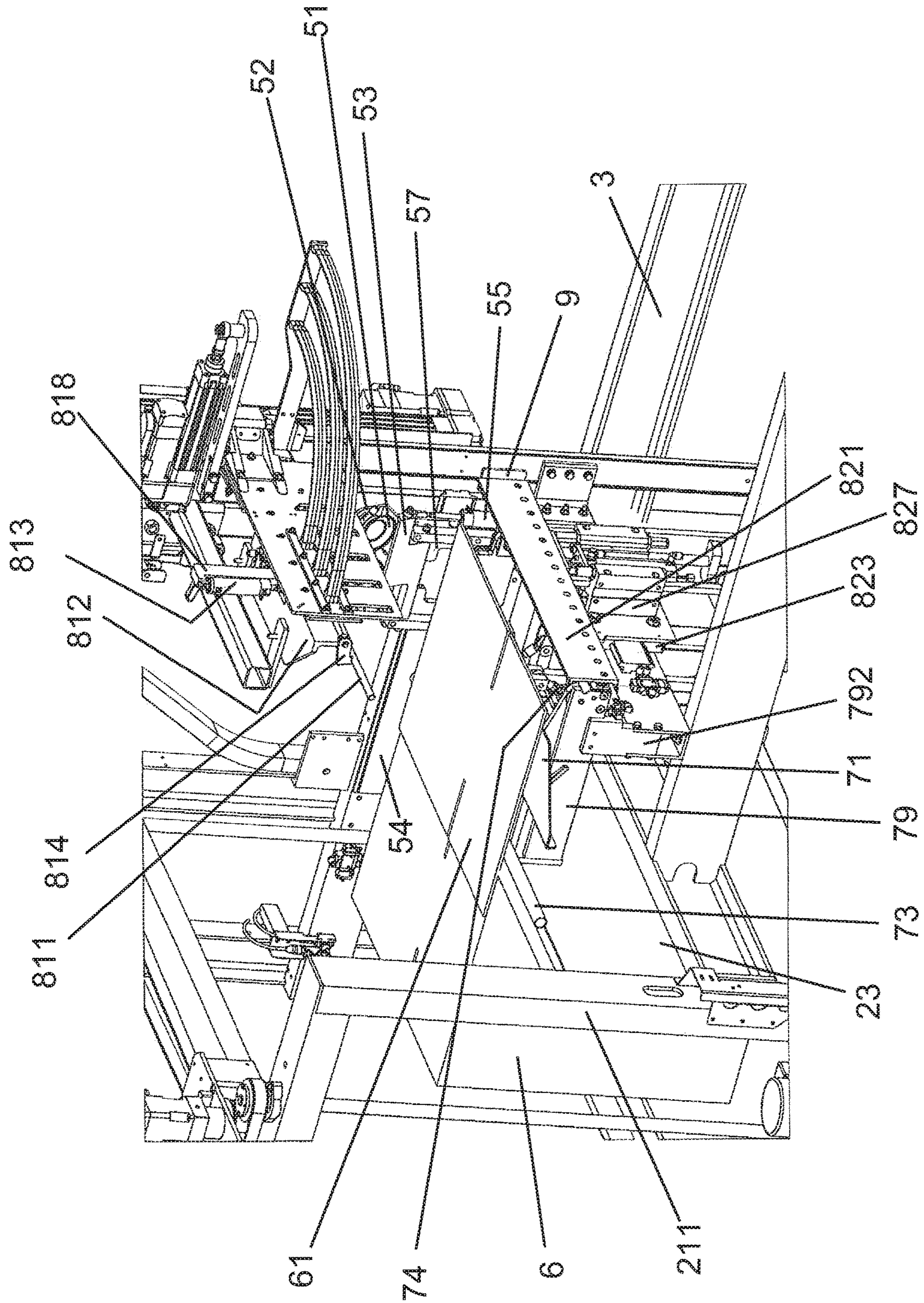


Fig. 15B



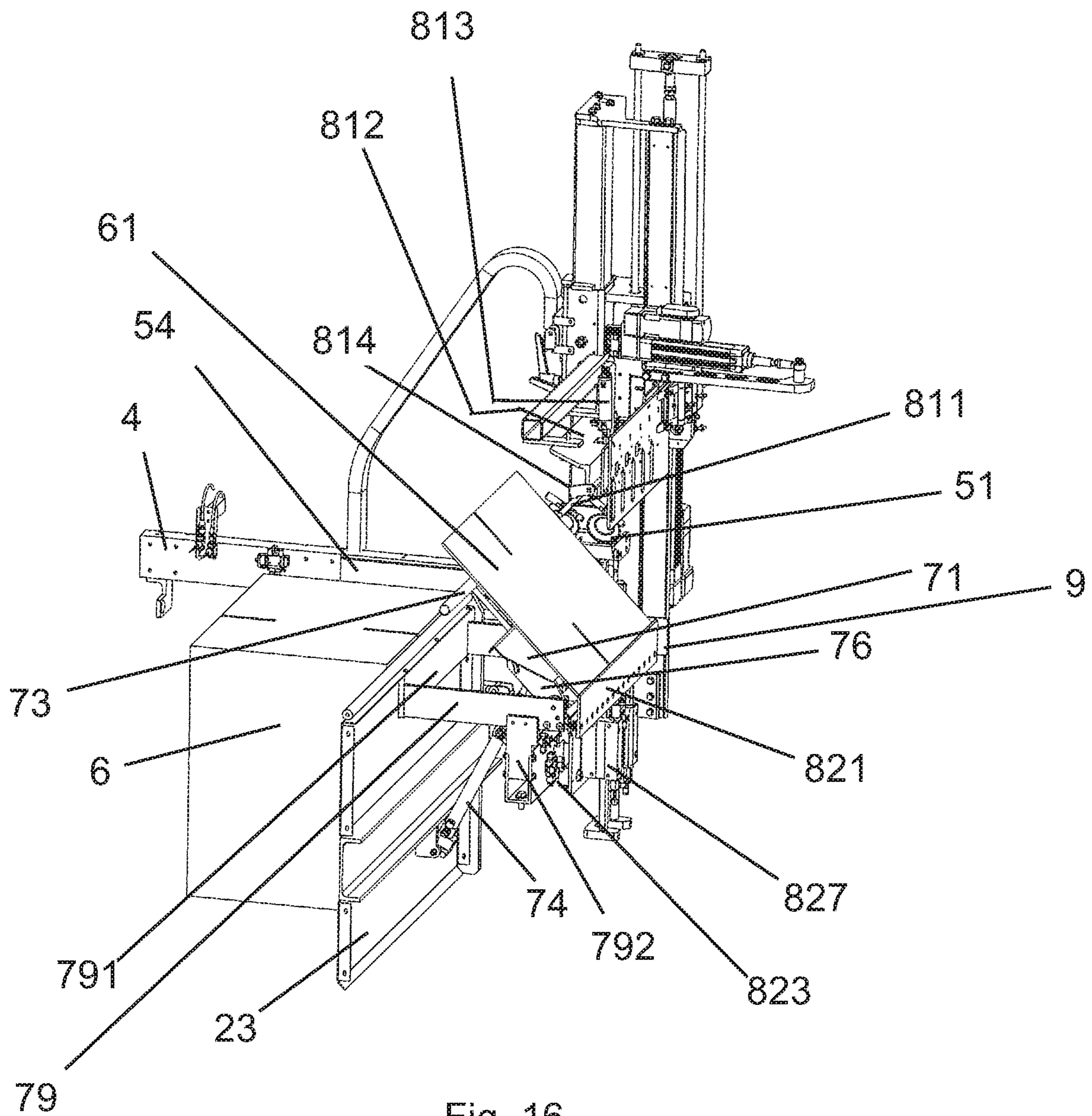


Fig. 16



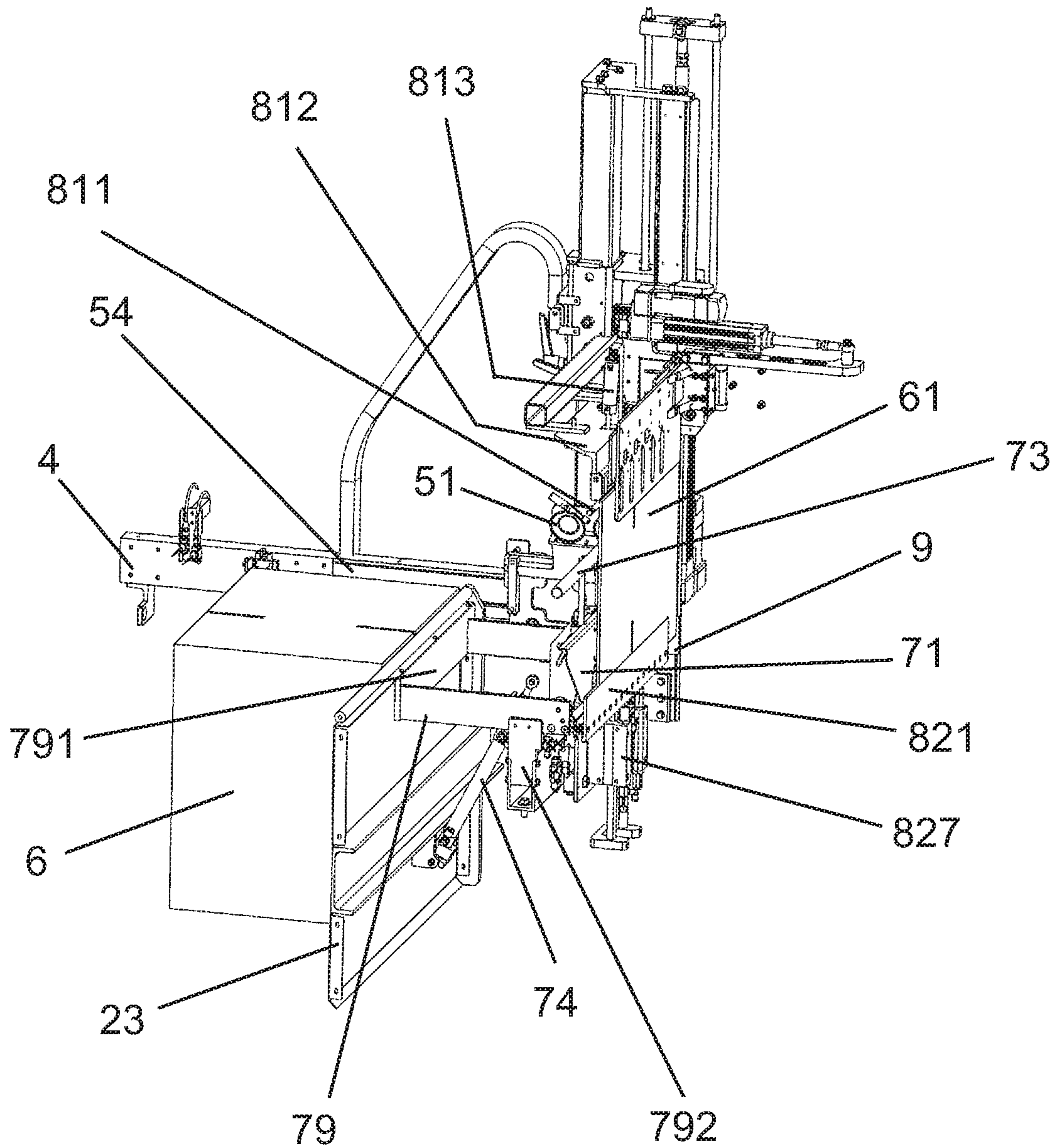


Fig. 17A

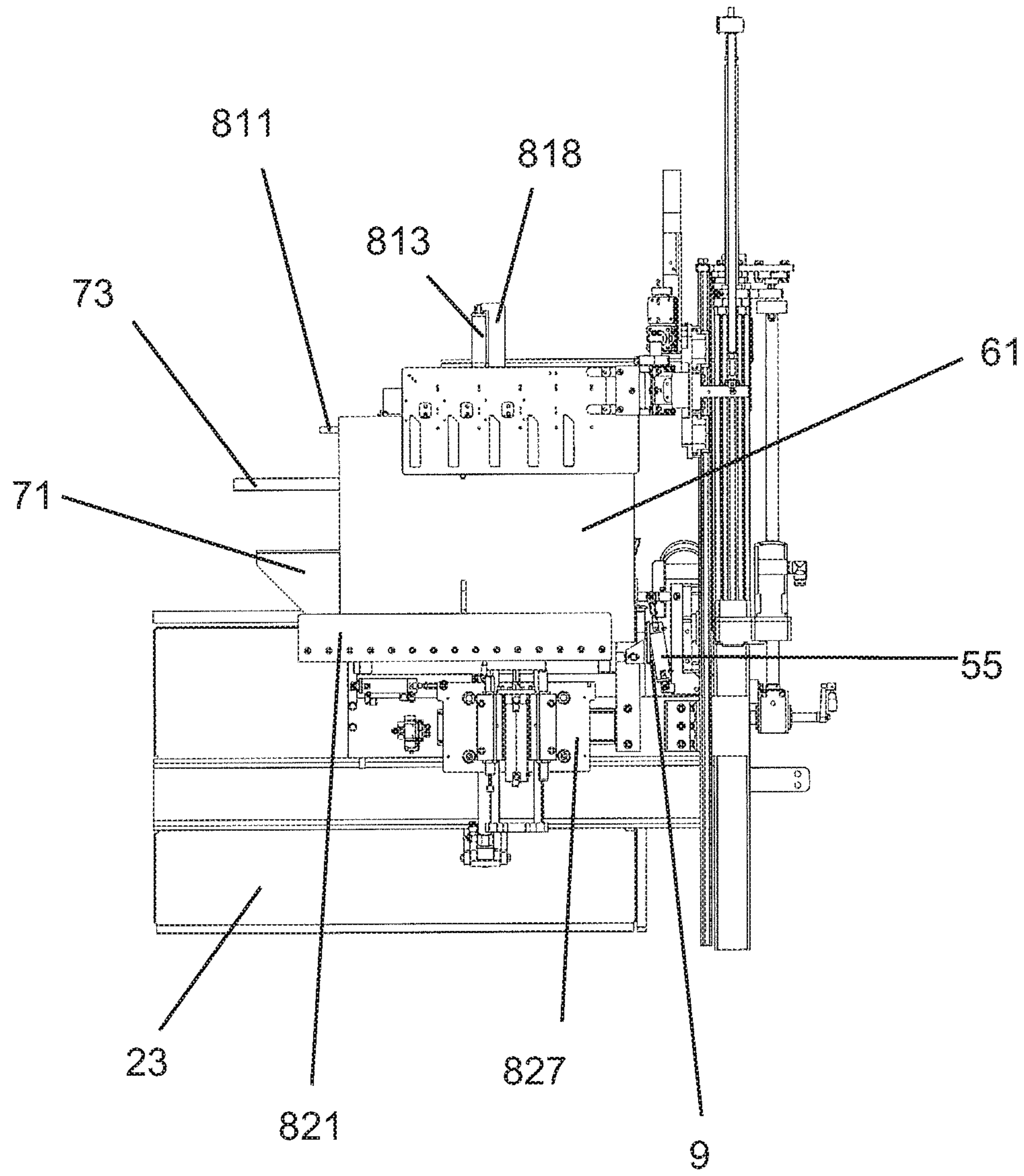


Fig. 17B

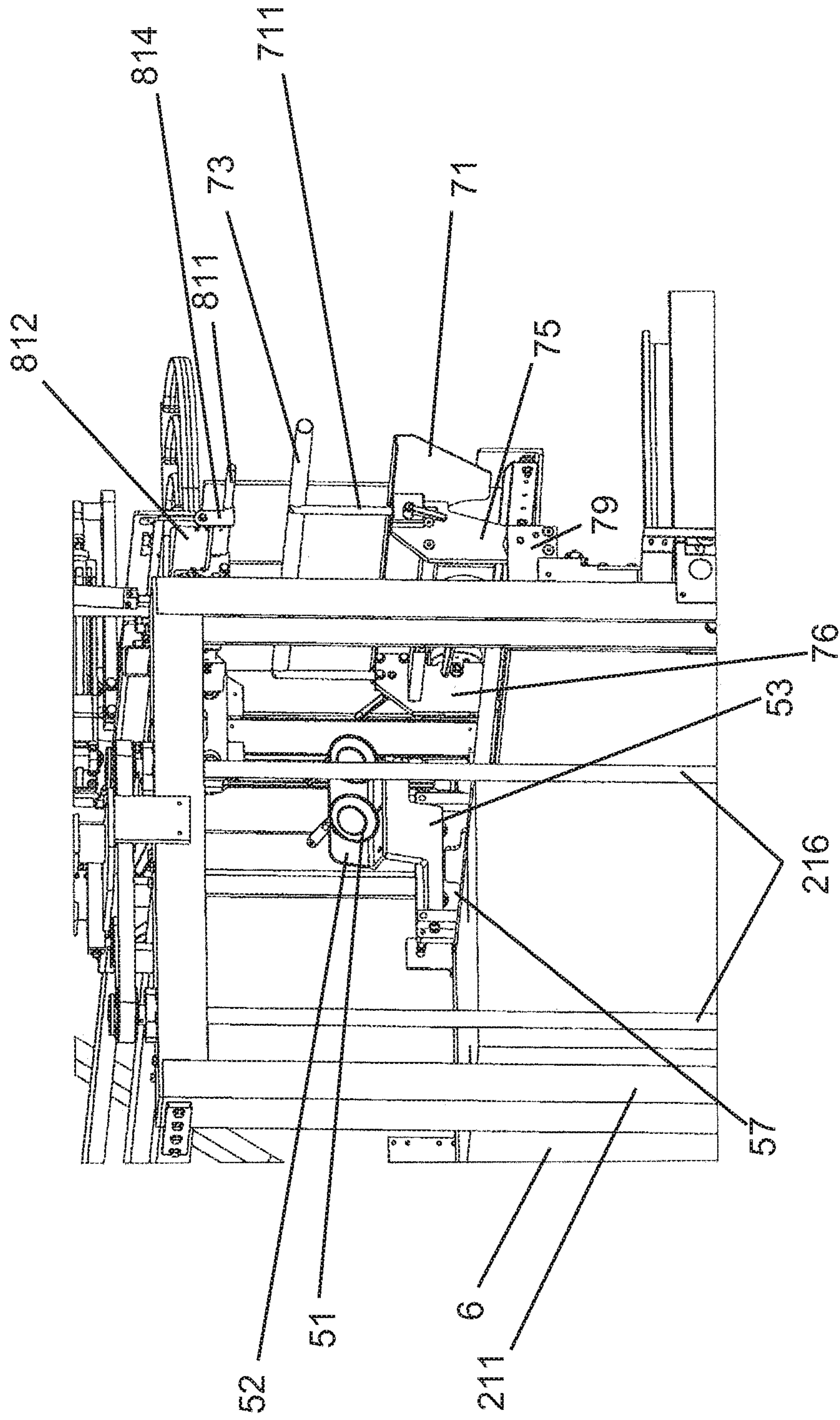


Fig. 17C



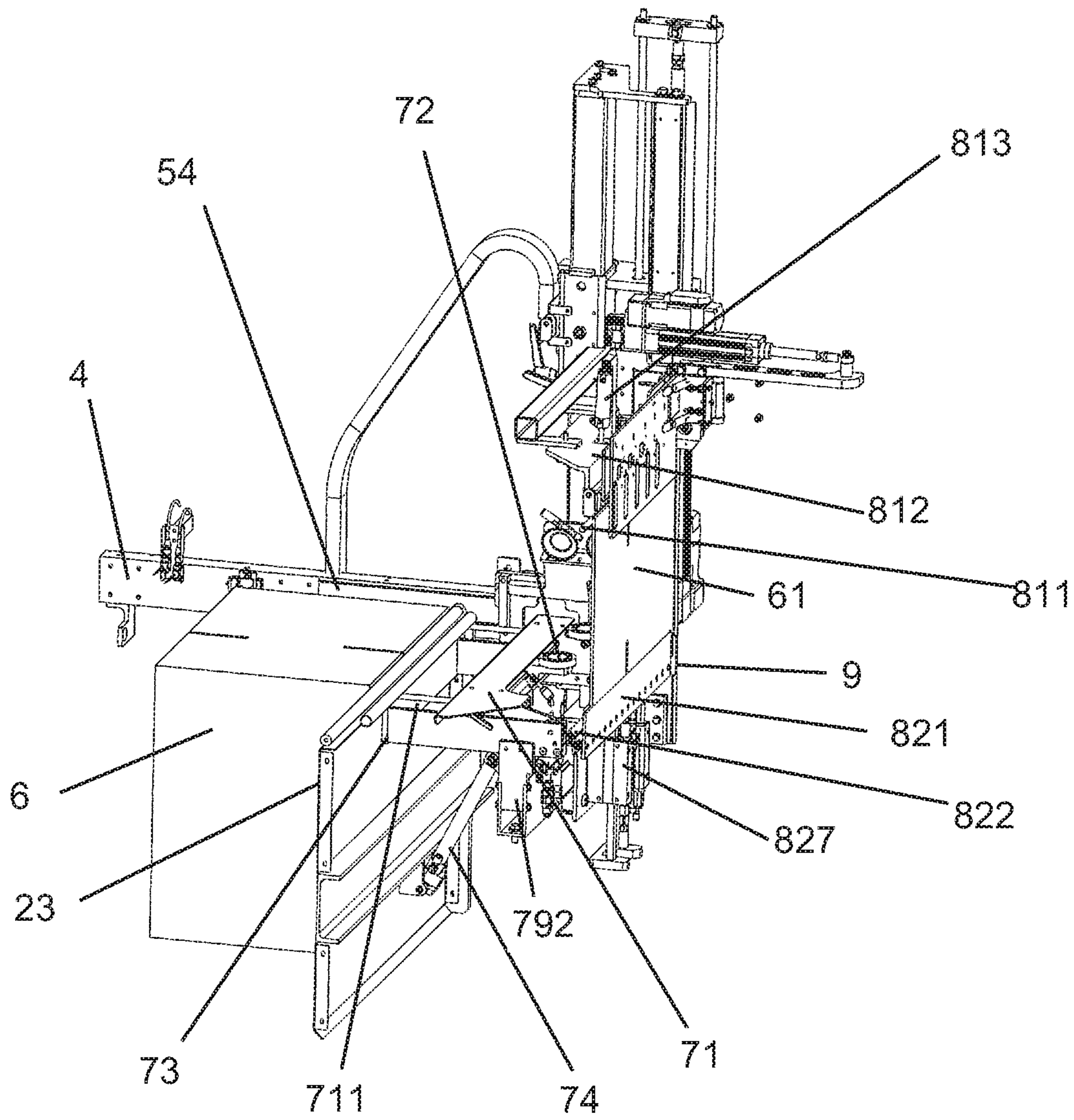


Fig. 18A

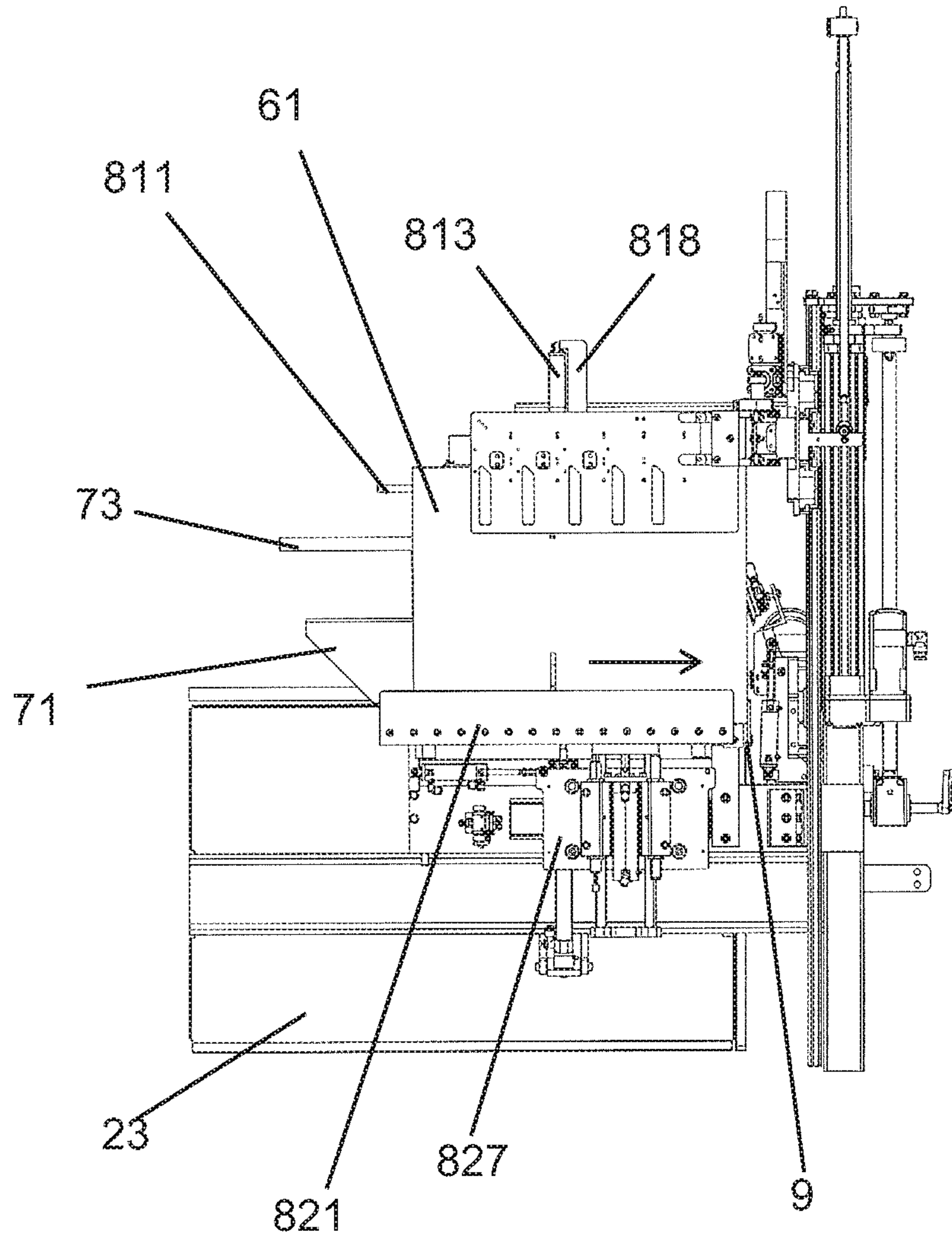


Fig. 18B

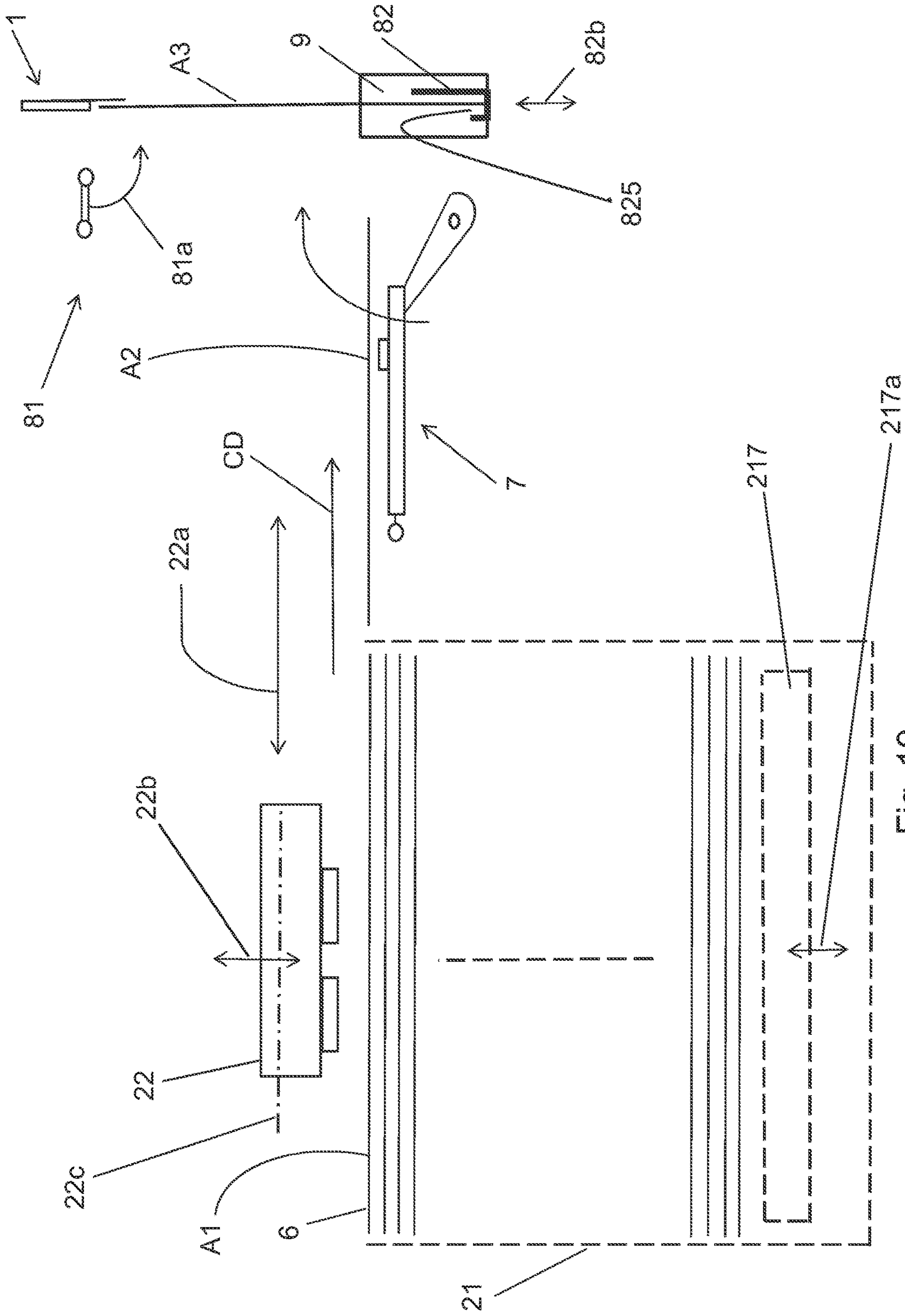


Fig. 19



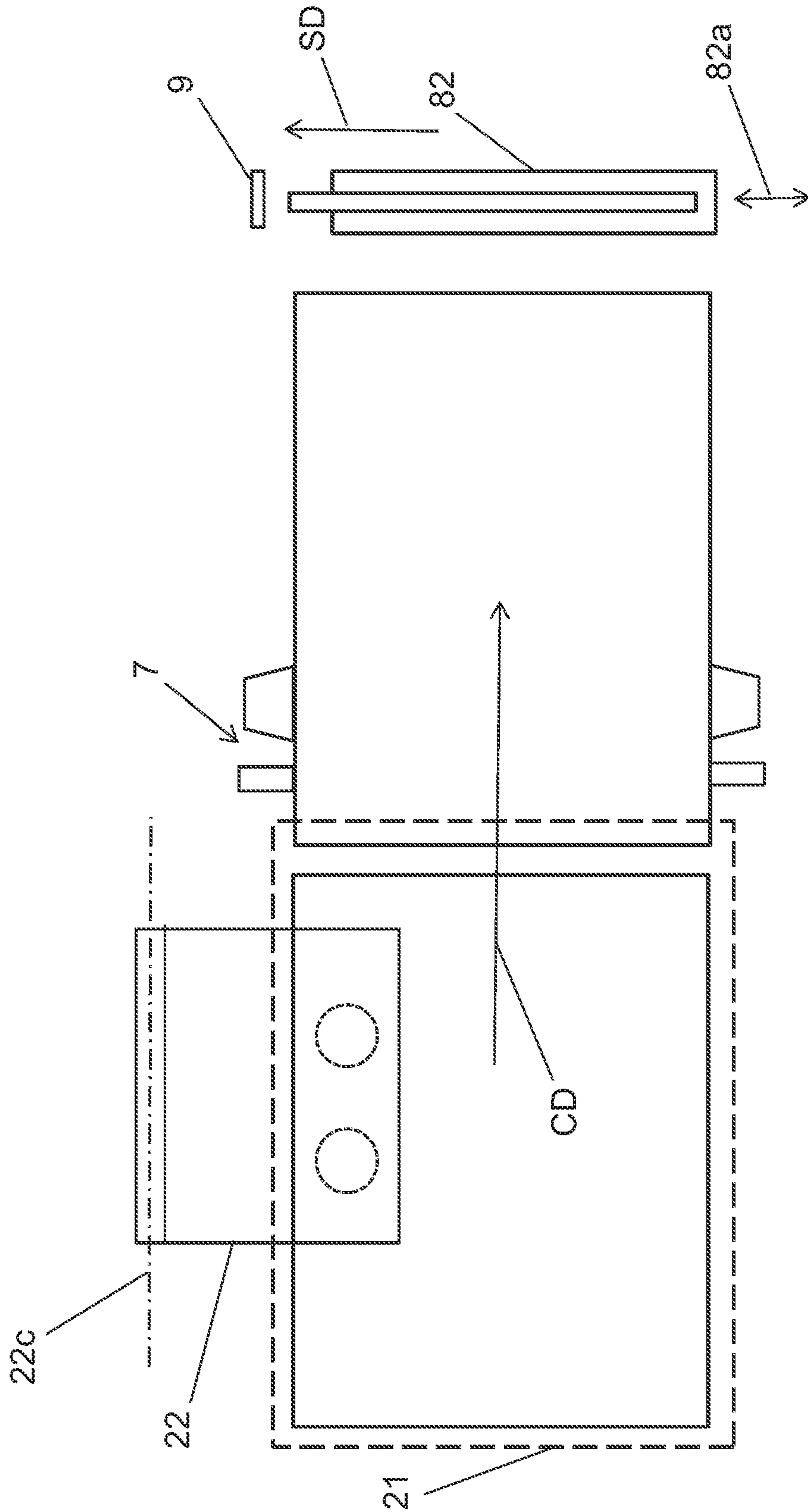


Fig. 20

## APPARATUS AND METHOD FOR ACCURATE CARTON FORMATION

### TECHNICAL FIELD

This application relates generally to carton erectors and more particularly to an apparatus for erecting folded carton blanks including an arrangement for accurate positioning of folded carton blanks relative to a carton opening device.

### BACKGROUND

In the packaging industry, carton forming machines, groups of vertically oriented folded carton blanks, and have carton blank feeders which, in general, are two types.

First, the carton blanks feeder consists of two long parallel carton blank holding arms mounted on the entrance of the carton forming machine. The two carton blank holding arms are mounted at the front of the carton forming machine at 45°, and two pusher arms are connected with the two parallel carton blank holding arms. At the lower end of each of the pusher arms, a heavy metal weight is hanging there to assist the cartons sliding on the carton holding arms. In use, a vertical pile of folded carton blanks are placed in the space inside the parallel carton blanks holding arms, the two sides of the carton blanks are held by the holding arms and at the back of the carton blanks, the pusher arm is attached at the last carton blank of the whole pile of the carton blanks and based on the gravity force and the downward slope formed by the holding arms, forming a slant to slide the carton blanks towards the folded carton blank opening device or suction cups.

Another type of carton blanks feeder is a set of two long carton blanks supporting arms. They are parallel to each other and mounted at the front end of the carton forming machine. At the bottom of the two long carton blanks supporting arms, two conveyor belts are mounted between these two long carton blanks supporting arms. A pusher arm is also mounted at one of the carton blanks supporting arms. In operation, the carton blanks are placed in the space between the two long carton blanks supporting arms and the carton blanks are driven to the carton forming machine by the conveyor belts. The pusher arm with sensors will push the carton blanks towards the machine to open by a folded carton blank opening device or by suction cups.

Problems of these two types of the carton blank feeding and transporting systems are: first, depending on the gravity force and the downward slope formed by the carton blank holding arms, forming a slant to slide the carton blanks can cause blanks to jam especially when the carton blanks have more friction and are not slippery enough to smoothly slide to the machine. For the second type of feeder, when the carton blanks are moving along the two long supporting arms towards the pin blocks or suction cups by a pusher, jams may occur because the blanks are loosely moving within the arms. Secondly, after a pile of vertically folded blanks are loaded, a manual adjustment/check must be done to ensure blanks are in the right position for blank opening. If the carton blanks are not in a right position, the machine may jam. This kind of adjustment is time consuming and tends to decrease the productivity of the machine and machine operator. Thirdly, the disadvantage of vertical carton blank feeders is that the carton blanks stand in the feeder on the carton flaps, and thus, the quality of the carton and the weight of the blanks may cause the carton blank to resist movement in the feeder and potentially jam. Further, if the user wants to load more carton blanks into the feeder at one

time, the carton blank feeder needs to be longer and longer, requiring a larger machine footprint.

One attempt can be found in U.S. Patent Publication No. 2016/0159026, in which a pile of horizontal folded carton blanks is placed in a storage rack which is located in front of a carton forming machine and at the bottom of the storage rack, a conveyor belt with a lug or lugs mounted on it is operated to push a folded carton blank out from the bottom of the stack. The lug or lugs on the conveyor belt will send the folded blank to the carton blank stand up device so that a folded carton blank opening device can stretch or pivot open the folded blank. In this attempt, the problems of jam or moving of the carton blanks in the traditional vertical folded carton blanks storage rack were addressed. But the machined design does not reset the position of the carton blanks accurately under the folded carton blank opening device for the opening step, and therefore the machine operator must position the carton blanks accurately when loading.

### SUMMARY

In one aspect, a carton forming machine includes a carton blank storage rack holding a carton blank stack formed by a plurality of substantially horizontal folded carton blanks. A carton blank transport device is arranged to pick a folded carton blank from the stack and transport the folded carton blank in a conveyance direction along a conveyance path toward a carton opening mechanism. A carton blank push up device receives the folded carton blank from the carton blank transport device and reorients the folded carton blank from the substantially horizontal orientation to an upright orientation below the carton opening mechanism. A carton blank positioning apparatus receives and supports the upright folded carton blank and shifts the upright folded carton blank in a set direction transverse to the conveyance direction in order to establish an accurate lateral position of the upright folded carton blank below the carton opening mechanism before the carton opening mechanism engages the upright carton blank for opening of the upright carton blank.

In another aspect, a carton forming machine includes a carton blank push up device that receives a substantially horizontal folded carton blank and reorients the folded carton blank from the substantially horizontal orientation to an upright orientation below and in a first direction alignment with a carton opening mechanism. A carton blank positioning apparatus shifts the upright folded carton blank in a second direction, transverse to the first direction, below the carton opening mechanism to define a second direction position of the upright carton blank below the carton opening mechanism before the carton opening mechanism engages the upright carton blank for opening of the upright carton blank.

In a further aspect, a method of handling carton blanks in a carton forming machine involves: (a) storing a plurality of substantially horizontally oriented folded carton blanks in a stack at a carton blank station; (b) automatically picking a folded carton blank from the top of the stack and conveying it in a substantially horizontal orientation along a conveyance path in a first direction toward a carton opening mechanism; (c) automatically shifting the folded carton blank of step (b) upward into an upright orientation with a first set position that is below and in a first direction alignment with the carton opening mechanism; and (d) automatically shifting the folded carton blank of step (c) in a second direction, transverse to the first direction, and into



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a second set position that is below and in a second direction alignment with the carton opening mechanism.

In one detailed example, a carton blank feeding system is mounted on the carton forming machine, which is located at the front of the machine. The carton blank feeding system includes a folded carton blank storage rack, and a folded carton blank transport device which includes a conveyor belt, a motor and three vertical threaded shafts attached to another motor. The folded carton blank storage rack allows a horizontal pile of folded carton blanks to load into it from the side (e.g., from a feed conveyor). The method of loading the folded carton blank storage rack is to put the carton blanks horizontally at a feed side of the folded carton blank storage rack and the conveyor belt will proceed in a forward direction to take the horizontal pile of folded carton blanks into the folded carton blank storage rack. The amount of blanks loaded in the folded carton blank storage rack will only make the pile of carton blanks higher and would not need more horizontal space to extend the folded carton blanks storage rack for placing more blanks. The conveyor belt not only can move forward, it can also move backward. The purpose of the forward movement is to take in the heavy pile of folded carton blanks into the carton blanks storage rack. On the other hand, the backward movement of the conveyor belt can help to move the unused folded carton blanks out of the carton blank storage rack in order to change to another type of folded carton blank. This arrangement saves the operator time putting in and taking out the folded carton blanks; especially, when the pile of folded carton blanks is heavy. A blocking plate is located at the front lower end of the carton blank storage rack, it is used to prevent the folded carton blanks from falling out of the carton blank storage rack when loading or unloading the folded carton blanks. The folded carton blank storage rack frame has four long flat metal bars that stand as four legs and on the top of each of these four legs there is a respective flat bar, resulting in four flat bars, each mounted to one of the legs to form the folded carton blanks storage rack frame. The folded carton blank transport device is mounted on a folded carton blank vertical transport device, and the folded carton blank vertical transport device on the folded carton blanks storage rack. On the top of the folded carton blank storage rack, a motor which belongs to the folded carton blank vertical transport device is mounted to drive the movement of one driven belt. The driven belt is connected with five pulleys to the three vertical threaded shafts. The three vertical threaded shafts are located at two sides of the folded carton blanks storage rack. These three vertical threaded shafts are mounted on the sides of the conveyor belt by two metal plates and a vertical bar. When the motor is operating, it can drive the driven belt to move the three vertical threaded shafts so as to let the conveyor belt move upward for folded carton blank pick up or downward for the re-load of folded carton blanks into the folded carton blank storage rack. In the middle of the folded carton blanks storage rack, a big “L” shape metal bar is mounted to connect the folded carton blanks storage rack with the carton forming machine. Above the a big “L” shape metal bar, another long small metal bar is mounted. This long small metal bar is used for mounting of the folded carton blank pick up device. The folded carton blank pick up device includes two suction cups, two pneumatic cylinders, and a movement bar which allows the suction cups to move forward to pick the top horizontal folded carton blank from the storage rack and with the second cylinder raise the vacuum cups out of the way of the folded carton blank stand up device, or to move backward to put the folded carton blanks on the folded carton blank stand up device. The

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folded carton blank stand up device includes a flat plate, two grippers, a long rod and a pneumatic cylinder. The long rod and flat plate are designed to handle different sizes of carton blanks, and therefore they are very long and in most of the cases, no need to adjust the long rod for bigger or smaller cartons. After the folded carton blank stand up device receives a folded carton blank, it will push the blank upward to stand up with the bottom flap falling into the bottom flap position device of the accurate carton apparatus. At this time, the accurate carton apparatus will grasp the folded carton blanks and position the blanks accurately under the folded carton blank opening device for opening by moving the bottom flap position device. The accurate carton apparatus includes the bottom flap position device and an upward driving pneumatic cylinder with a vertical slide. The bottom flap position device includes a pneumatic cylinder which causes movement in a horizontal direction for lateral positioning below the carton blank opening device. The top flap push device is a long rod which is used to press the carton blanks against the folded carton blank opening device, a “ $\sqcap$ ” shaped plate and a pneumatic cylinder.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the carton forming machine with folded carton blanks storage rack and folded carton blank opening device;

FIG. 2 is a side view of the carton forming machine from folded carton blanks storage rack to folded carton blank opening device;

FIG. 3 is a top view of the carton forming machine from folded carton blanks storage rack to Folded carton blank opening device;

FIG. 4 is a perspective view of the folded carton blanks transport device and folded carton blank vertical transport device;

FIG. 5 is a perspective view of the carton blanks transport conveyor device;

FIG. 6 is a perspective view of the folded carton blank pick up device;

FIG. 7 is a perspective view of the folded carton blank stand up device;

FIG. 8A-8D is different view of the folded carton blank stand up device;

FIG. 9 is a perspective view of the top flap push device;

FIG. 10A-10D is different view of the top flap push device;

FIG. 11 is a perspective view of the accurate carton apparatus and bottom flap position device;

FIGS. 12-18B depict an illustration of how the carton blanks feeding system transports carton blanks to the carton blanks erecting device;

FIG. 19 is a schematic side elevation of the case forming apparatus; and

FIG. 20 is a schematic top plan view of FIG. 19 with carton opening device not shown.

#### DETAILED DESCRIPTION

Referring to FIGS. 19 and 20, the basic operation of a carton feed assembly of a carton forming machine is shown schematically. A carton blank storage rack 21 holds a carton blank stack formed by a plurality of substantially horizontal



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folded carton blanks **6**. The storage rack includes a conveyor belt mechanism **217** that can also be raised to feed the carton blank stack upward, and lowered to load more carton blanks, per arrow **217a**. A carton blank transport device **22** is movable per arrows **22a** and is arranged to pick a folded carton blank from the top of the stack (position **A1**) and transport the folded carton blank in a conveyance direction **CD** along a conveyance path toward a carton opening mechanism **1** (into position **A2**). A carton blank push up or stand up device **7** receives the folded carton blank from the carton blank transport device (at position **A2**) and reorients the folded carton blank from the substantially horizontal orientation to an upright orientation below the carton opening mechanism **1** (position **A3**). A carton blank positioning apparatus **82** (also referred to as an accurate carton apparatus) receives and supports the upright folded carton blank and is movable per arrows **82a** to shift the upright folded carton blank in a set direction **SD** transverse (here substantially perpendicular) to the conveyance direction **CD** in order to establish an accurate lateral position of the upright folded carton blank below the carton opening mechanism **1** before the carton opening mechanism engages the upright carton blank for opening of the upright carton blank. Thus, a correct position of the carton blank in both direction **CD** and direction **SD**, relative to the overhead carton opening mechanism **1**, is achieved. The carton opening mechanism **1** may be of a type utilizing jaw plates with pins that engage the carton as describe in any of U.S. Pat. No. 4,553,954 or later variations such as those shown in U.S. Pat. Nos. 7,131,941, 7,192,393 or 7,422,552. The carton opening mechanism shifts the carton blank slightly in further direction **SD** as the carton blank is opened, and can then be moved downward into contact with the flap closing arms to close the bottom of the carton. The opened carton blank can then be conveyed further in set direction **SD** to a bottom tape sealing device (not shown) that tapes the bottom of the opened carton blank.

The carton blank transport device **22** is arranged above the carton blank storage rack and picks the folded carton blank from a top of the stack. The transport device **22** may include a pair of suction cups to pick up the carton blank and is movable along a support rail per arrows **22a**, as will be described in greater detail below. The transport device **22** also moves up and down per arrows **22b** (which may be achieved by a pivoting motion of the device about a horizontal axis **22c** as will be described in further detail below).

The carton blank positioning apparatus includes an elongated bar/rail/member with an upward facing receiving slot or groove **825** in which bottom edges of flaps on the carton blank are positioned when the carton blank is moved into the upright orientation. The elongated bar/rail/member **82** is movable in the set direction **SD**. The carton blank positioning apparatus **82** includes a stop surface **9** toward one end of the elongated bar/rail/member. The elongated bar/rail/member moves in the set direction **SD** such that one side of the upright carton blank contacts the stop surface **9** to define the accurate lateral position of the upright folded carton blank. After the one side of the carton blank contacts the stop surface **9**, continued movement of the elongated bar/rail/member in the set direction causes the elongated bar to slide relative to the upright carton blank sitting in the receiving slot/groove. A position of the stop surface **9** along the set direction **SD** may be adjustable to permit adjustment to accommodate different carton blank sizes. The elongated bar/rail/member is in a first position when the upright carton blank is initially loaded into the receiving slot, and one side of the upright carton blank protrudes beyond one end of the

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elongated bar when initially loaded, as per FIG. **20**. The elongated bar/rail/member **82** can also be moved up and down per arrows **82b** in order to engage the upright carton blank onto the carton opening device **1**.

The carton blank positioning device includes a top flap pusher **81** movable between an upright position (shown in FIG. **19**) and a lowered push position (achieved per arrow **81a**). In the upright position, the top flap pusher **81** is above a travel path of a carton blank as the carton blank moves from the substantially horizontal orientation to the upright orientation, and in the lowered push position, the top flap pusher engages a trailing side of the carton blank top flaps. As shown, the top flap pusher may be mounted for pivotal movement between the upright position and the lowered push position. The top flap pusher **81** pushes a leading side of some of the top flaps against a panel member of the carton opening mechanism **1**.

Thus, a method of handling carton blanks in a carton forming machine, the method comprising: (a) storing a plurality of substantially horizontally oriented folded carton blanks in a stack at a carton blank station; (b) automatically picking a folded carton blank from the top of the stack and conveying it in a substantially horizontal orientation along a conveyance path in a first direction toward a carton opening mechanism; (c) automatically shifting the folded carton blank of step (b) upward into an upright orientation with a first set position that is below and in a first direction alignment with the carton opening mechanism; and (d) automatically shifting the folded carton blank of step (c) in a second direction, transverse to the first direction, and into a second set position that is below and in a second direction alignment with the carton opening mechanism. For continuous operation, repeating steps (b), (c) and (d) for multiple folded carton blanks in the stack takes place. In step (c), the shifting operation loads the folded carton blank into a receiving slot in a bar/rail/member, and in a step (e) after step (d), the bar/rail/member upward to push the folded carton blank into engagement with a carton opening mechanism that operates to open the folded carton blank.

Referring now collectively to FIGS. **1-20**, various detailed structures of the machine are shown. At the front part of the carton forming machine **1** is the folded carton blanks feeding system **2** which include a folded carton blanks storage rack **21**, a folded carton blanks transport device **22** and a blocking plate **23**. The said folded carton blanks storage rack **21** has four long flat metal bars **211**, the four long flat metal bars **211** form the legs of the folded carton blanks storage rack **21**. Another four flat bars **212** are mounted on the top of the four long flat metal bars **211** so as to form the frame of the folded carton blanks storage rack **21**. In the folded carton blanks storage rack **21**, the folded carton blanks transport device **22** is mounted. On the flat bars **212**, a motor **213** which belongs to folded carton blanks transport device **22** is mounted. The motor **213** is connected with five pulleys **214** by one driven belt **215**. Three of the said pulleys **214** are connected to three vertical threaded shafts **216**. The said three vertical threaded shafts **216** are mounted on the opposite sides of the folded carton blanks storage rack **21** and pass through two metal plates **219** and a vertical bar **210** so as to link with the conveyor belt **217**. The conveyor belt **217** is driven to move inward and outward by another motor **218**. At the front end of the conveyor belt **217**, a blocking plate **23** is installed to avoid the falling of the folded carton blanks into the machine. At one side of the folded carton blanks storage rack **21**, a big “L” shape metal bar **3** is mounted to connect the folded carton blanks storage rack **21** with the carton forming machine **1**. Above the big “L” shape metal bar **3**, another



long small metal bar 4 is mounted. This long small metal bar 4 is used for the folded carton blank pick up device 5 to mount on it.

When working, a pile of horizontal folded carton blanks 6 is placed at the entrance of the carton blank storage rack 21, then the motor 218 will drive the conveyor belt 217 to move inward to take the pile of horizontal folded carton blanks 6 from the entrance of the folded carton blanks storage rack 21 into the storage rack 21. The blocking plate 23 will prevent the pile of horizontal folded carton blanks 6 from falling into the machine. Then, the motor 213 of the folded carton blanks transport device 22 will drive the five pulleys 214 and the one driven belt 215 to move and as the pulleys 214 are connected with the three vertical threaded shafts 216, then the three vertical threaded shafts 216 will drive the conveyor belts 217 to move upward for folded carton blank pick up or move downward for re-load of folded carton blanks. At the same time, the folded carton blank pick up device 5 is starting to pick up the top horizontal folded carton blanks 61. The folded carton blank pick up device has two suction cups 51 which are mounted on a “⊃” shaped short plate 52, this “⊃” shaped short plate 52 is mounted on a flat plate 53 and the flat plate 53 is mounted on two vertical small bars 56. The two vertical small bars 56 connected with a moving bar 54 and a pneumatic cylinder 55 is linked with the flat plate 53 and is used to push the suction cups 51 to swing down to pick up the top horizontal folded carton blanks 61 to the folded carton blank stand up device 7. The folded carton blank stand up device 7 is composed of a long flat plate 71, two grippers 72, a long rod 73 and a pneumatic cylinder 74.

The accurate carton apparatus 8 is mounted behind the folded carton blank stand up device 7. The said accurate carton apparatus 8 has a bottom flap position device 82 and upward driving pneumatic cylinder with vertical slide 829. The top flap push device 81 includes a long rod 811, a “⊃” shaped plate 812 and a pneumatic cylinder 813. The bottom flap position device 82 has a “L” shape bar 821, a small long bar 822, a moving rail 823, and a pneumatic cylinder 824.

The folded carton blanks storage rack 21 is mounted at the front of the carton forming machine 1. The folded carton blanks transport device 22 is mounted in the folded carton blanks storage rack 21 and at the end of the folded carton blanks transport device 22 is the folded carton blank pick up device 5. At the side of the folded carton blank pick up device 5 is the folded carton blank stand up device 7. The accurate carton apparatus 8 is located behind the folded carton blank stand up device 7.

The carton blanks feeding system 2 includes a folded carton blanks storage rack 21, a folded carton blanks transport device 22 and a blocking plate 23. The folded carton blanks storage rack 21 has four long flat metal bars 211 and they form the legs of the folded carton blanks storage rack 21. On the top of the four long flat metal bars 211, four flat bars 212 are mounted to form the frame of the folded carton blanks storage rack 21. In FIG. 4, the folded carton blanks transport device 22 is composed of a motor 213, five pulleys 214 which are linked with one driven belt 215, a conveyor belt 217 and a motor 218. Three of the said pulleys 214 are mounted on three vertical threaded shafts 216. When the motor 213 drives the driven belt 215 to move, then the pulleys 214 connected with the driven belt 215 are also moved; as the pulleys 214 are connected with the three vertical threaded shafts 216, the action will drive the conveyor belt 217 moving upward for top horizontal folded carton blank 6 pick up or moving downward for re-load of

folded carton blanks. The motor 218 can move the conveyor belt 217 inward or outward so as to help load or eject the folded carton blanks.

At the one side of the conveyor belt 217, two metal plates 219 are mounted and each metal plate 219 has a hole 2191 on the center which allows the vertical long moving rods 216 to pass through. At the opposite side, a vertical bar 210 is mounted with the conveyor belt 217. The said vertical bar 210 is used for one of the vertical long moving rod 216 to link with. In FIG. 5, the motor 218 is located at the side of the conveyor belt 217, which is used to drive the conveyor belt 217 to move inward or outward.

The folded carton blank pick up device 5 has two suction cups 51 which are mounted on a “⊃” shape short plate 52, this “⊃” shape short plate 52 is mounted on a flat plate 53 and the said flat plate 53 is mounted on two vertical small bars 56. Then the two vertical small bars 56 are mounted a rectangular shape plate 57 and this rectangular shape plate 57 is mounted on a moving bar 54 and a pneumatic cylinder 55 is used to push the suction cups 51 to swing down to pick up the top horizontal folded carton blanks 61. Another pneumatic cylinder 58 is mounted at the bottom of the rectangular shape plate 57, it is used to move forward or backward of suction cups 51 that are mounted on the rectangular shape plate 57. The forward movement lets the suction cups 51 to reach the carton storage rack 21 to pick the top horizontal folded carton blank 61 and go back to the original position to place the horizontal folded carton blank 61 on the folded carton blank stand up device 7.

The folded carton blank stand up device 7 composed of a long flat plate 71, two grippers 72, a long rod 73 and a pneumatic cylinder 74. The said long flat plate 71 is mounted on two metal plates 75, 76 respectively. On the top of the metal plate 75, a gripper 72 is mounted and cannot move. A movable rod 77 is also mounted on the middle of the two metal plates 75, 76. This movable rod 77 allows another gripper 72 to mount on it and the said gripper 72 is movable along the movable rod 77 with a switch 721. The purpose of the movable gripper 72 is to allow the adjustment of the distance between the two grippers 72 so as to hold abnormally large or small size folded carton blanks. Adjustment requires only switching the switch 721 and move the gripper 72 and locking the switch 721 again, which is very easy. Below the movable rod 77, a bar 78 is mounted between the two metal plates 75, 76. At the middle of the bar 78, a “∩” shape small metal 781 is mounted which is used to link with the pneumatic cylinder 74. At the back of the long flat plate 71, two small rods 711 are mounted and connected to the long rod 73. The two metal plates 75, 76 are connected to two long rectangular bars 79. The two long rectangular bars 79 allow the two metal plates 75, 76 to be movable. At the back of the two long rectangular bars 79, another long bar 791 is mounted to the bars and on the blocking plate 23. In FIG. 7, the two long rectangular bars 79 are mounted on two small metal bars 792.

FIGS. 8a-8d is different views of the folded carton blank stand up device 7. FIG. 8a, FIG. 8c and FIG. 8d show the top, side and front views of the folded carton blank stand up device 7. FIG. 8b shows the structure view of the folded carton blank stand up device 7.

At the back of the long flat plate 71, two small rods 711 are mounted. The two small rods 711 are connected with the long rod 73. One of the gripper 72 is mounted on the metal plate 75 and cannot move. The two metal plates 75, 76 are connected with two long rectangular bar 79. The whole folded carton blank stand up device 7 is mounted on the blocking plate 23.



The top flap push device **81** of the accurate carton apparatus **8** includes a long rod **811**, a “ $\neg$ ” shape plate **812** and a pneumatic cylinder **813**. The long rod **811** has a pair of flat plates **814** which are used to mount on the “ $\neg$ ” shape plate **812**. At the center of the long rod **811**, two plates **815** are mounted. The two plates **815** connected with a “ $\perp$ ” shape metal **816**. At the center of the “ $\neg$ ” shape plate **812**, a hole **817** is used to let the vertical “ $\Gamma$ ” shape bar **818** to pass through. The vertical “ $\Gamma$ ” shape bar **818** is mounted to the pneumatic cylinder **813** and the pneumatic cylinder **813** is connected to the “ $\perp$ ” shape metal **816** to allow the pneumatic cylinder **813** to push the long rod **811** forward and backward in order to press the folded carton blank **61** firmly under the folded carton blank opening device (known technology).

The bottom flap positioning device **82** of the accurate carton apparatus **8** has a “ $\perp$ ” shape bar **821**, a small long bar **822**, a moving rail **823**, and a pneumatic cylinder **824**. The “ $\perp$ ” shape bar **821** and the small long bar **822** are mounted together and form a groove **825**. The groove **825** allows the bottom flap of the folded carton blank **61** to fall in it. The “ $\perp$ ” shape bar **821** and the small long bar **822** are mounted on a trapezoid shape flat bar **826**. The trapezoid shape flat bar **826** is connected with four rods **829**. These four rods **829** are mounted on a thick metal bar **827**. The thick metal bar **827** is mounted on a flat plate **828**. On the other side of the flat plate **828**, a moving rail **823** is mounted. At the front end of the flat plate **828**, the pneumatic cylinder **824** is mounted. The pneumatic cylinder **824** will push the flat plate **828**, which is linked with the “ $\perp$ ” shape bar **821** and the small long bar **822**, causing movement forward or backward in order to position the bottom flap of the folded carton blank **61** by hitting the side of the folded carton blank **61** to the position bar **9** located at the side under the folded carton blank opening device for flaps opening.

FIG. **12-18b** show the operational views depicting how the carton forming machine **1** moves and stretches open a horizontal folded carton blanks **61**. In FIG. **12**, a pile/stack of horizontal folded carton blanks **6** is placed in the folded carton blanks storage rack (not shown). The suction cups **51** of the folded carton blank pick up device **5** are in an up position, which is in preparation to pick up a horizontal folded carton blank **61**. Per FIG. **12**, the rectangular shape plate **57**, is controlled by the pneumatic cylinder **58** to move forward to the pile of horizontal folded carton blanks **6** and the suction cups **51** are controlled by the pneumatic cylinder **55** swing down to pick up the top horizontal folded carton blank **61**. At the same time, the folded carton blank stand up device **7** and the accurate carton apparatus **8** are in a ready state. FIGS. **14a** and **14b** are the different views showing how the folded carton blank **61** is transported to the folded carton blank stand up device **7**. In detail, after the suction cups **51** pick up the folded carton blank **61**, the pneumatic cylinder **58** will move backward and transport the folded carton blank **61** to the folded carton blank stand up device **7**. In FIGS. **15a** and **15b**, after the suction cups **51** place the folded carton blank **61** on the folded carton blank stand up device **7**, the suction cups **51** will release the folded carton blank **61** and the pneumatic cylinder **55** will drive the flat plate **53** back to an up position. Referring to FIG. **16**, the folded carton blank **61** is pushed up gradually by the folded carton blank stand up device **7**, and the bottom flap of the folded carton blank **61** is inserted inside the groove **825** under folded carton blank opening device. FIGS. **17a-17c** show the folded carton blank **61** standing vertically under the folded carton blank opening device and the bottom flap of the folded carton blank **61** within the groove **825** formed

between the said “ $\perp$ ” shape bar **821** and the small long bar **822**. In order to prevent the folded carton blank **61** from falling back down, the long rod **73** and the long flat plate **71** of the folded carton blank stand up device **7** remain in the vertical position so as to press the folded carton blank **61** to stand vertically. At the same time, in order to aid in preventing the folded carton blank **61** falling back, the long rod **811** of the top flap push device **81**, controlled by pneumatic cylinder **813** will press the folded carton blank **61** against the folded carton blank opening device. As shown in FIGS. **18a** and **18b**, the folded carton blank **61** stands vertically with the bottom flap entered into the groove **825** formed by the said “ $\perp$ ” shape bar **821** and the small long bar **822**. The pneumatic cylinder **824** of the accurate carton apparatus **82** will then move backward, causing the “ $\perp$ ” shape bar **821** and the small long bar **822** to also move backward and causing the side of the folded carton blank **61** to move into contact with the positioning bar **9** and finally position the folded carton blank **61** accurately under the folded carton blank opening device.

It is to be clearly understood that the above description is intended by way of illustration and example only, is not intended to be taken by way of limitation, and that other changes and modifications are possible.

What is claimed is:

1. A carton forming machine, comprising:

- a carton blank storage rack holding a carton blank stack formed by a plurality of substantially horizontal folded carton blanks;
  - a carton blank transport device arranged to pick a folded carton blank from the carton blank stack and transport the folded carton blank in a conveyance direction along a conveyance path toward a carton opening mechanism;
  - a carton blank push up device that receives the folded carton blank from the carton blank transport device and reorients the folded carton blank from the substantially horizontal orientation to an upright orientation below the carton opening mechanism to provide an upright folded carton blank; and
  - a carton blank positioning apparatus that receives and supports the upright folded carton blank and shifts the upright folded carton blank in a set direction transverse to the conveyance direction in order to establish an accurate lateral position of the upright folded carton blank below the carton opening mechanism before the carton opening mechanism engages the upright carton blank for opening of the upright carton blank;
- wherein the carton blank positioning apparatus includes an elongated bar with an upward facing receiving slot in which bottom edges of flaps on the upright folded carton blank are positioned, wherein the elongated bar, including the upward facing receiving slot, is movable in the set direction in order to shift the upright folded carton blank in the set direction to establish the accurate lateral position;
- wherein the carton blank push up device receives the folded carton blank from the carton blank transport device at a location in which the folded carton blank is spaced, along the conveyance direction, from the upward facing receiving slot of the carton blank positioning apparatus.

2. The carton forming machine of claim 1 wherein the carton blank transport device is arranged above the carton blank storage rack and picks the folded carton blank from a



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top of the carton blank stack, the carton blank transport device including at least one suction cup to engage the folded carton blank.

3. The carton forming machine of claim 1 wherein the carton blank positioning apparatus includes a stop surface in line with one end of the elongated bar, the elongated bar moves in the set direction such that one side of the upright folded carton blank contacts the stop surface to define the accurate lateral position of the upright folded carton blank.

4. The carton forming machine of claim 3 wherein after the one side of the upright folded carton blank contacts the stop surface continued movement of the elongated bar in the set direction causes the elongated bar to slide relative to the upright folded carton blank sitting in the upward facing receiving slot.

5. The carton forming machine of claim 3 wherein a position of the stop surface along the set direction is adjustable to permit adjustment to accommodate different carton blank sizes.

6. The carton forming machine of claim 1 wherein the elongated bar is in a first position when the upright folded carton blank is initially loaded into the upward facing receiving slot, and one side of the upright folded carton blank protrudes beyond one end of the elongated bar.

7. A carton forming machine, comprising:

a carton blank push up device that receives a substantially horizontal folded carton blank and reorients the substantially horizontal folded carton blank to an upright orientation to provide an upright folded carton blank below and in a first direction alignment with a carton opening mechanism; and

a carton blank positioning apparatus that shifts the upright folded carton blank in a second direction, transverse to the first direction, below the carton opening mechanism to define a second direction position of the upright folded carton blank below the carton opening mechanism before the carton opening mechanism engages the upright folded carton blank for opening of the upright folded carton blank;

wherein the carton blank positioning apparatus includes an elongated member with an upward facing slot sup-

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porting bottom edges of flaps on the upright folded carton blank and the elongated member, including the upward facing slot, is movable in the second direction in order to define the second direction position;

wherein the carton blank positioning apparatus includes a stop surface toward one end of the elongated member, wherein the elongated member, including the upward facing slot, is movable in the second direction such that one side of the upright folded carton blank contacts the stop surface to define the second direction position of the upright folded carton blank.

8. The carton forming machine of claim 7 wherein the carton blank positioning device includes a top flap pusher movable between an upright position and a lowered push position, in the upright position the top flap pusher is above a travel path of the substantially horizontal folded carton blank as the substantially horizontal folded carton blank moves from the substantially horizontal orientation to the upright orientation, in the lowered push position the top flap pusher engages a trailing side of top flaps of the substantially horizontal folded carton blank.

9. The carton forming machine of claim 8 wherein the top flap pusher is mounted for pivotal movement between the upright position and the lowered push position.

10. The carton forming machine of claim 8 wherein the top flap pusher pushes a leading side of some of the top flaps against a panel member of the carton forming machine.

11. The carton forming machine of claim 7 wherein the carton blank push up device includes a first gripper and a second gripper, the first gripper has a fixed position and the second gripper is movable in the second direction to enable adjustment of a spacing between the first gripper and the second gripper to accommodate different carton blank sizes.

12. The carton forming machine of claim 11 wherein an actuator is operatively connected for movement of the second gripper, and the actuator is controllable by a switch that is configured to be manually activated when the carton forming machine is not operating to form cartons.

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