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MACHINE À PLIER

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Description

[0001] The invention relates to a bending machine for forming workpieces by bending.

[0002] Bending machines, such as for example press brakes, are often designed for operation with different bending tools, which implement the bending of a corresponding workpiece during operation.

[0003] The exchange of bending tools requires the opening or closing of a corresponding holding device on the bending machine. In the prior art, holding devices are known that must be opened or closed manually by a human operator. Such manual holding devices require the physical effort of the operator and require long changeover times for the bending tools.

[0004] Automatic holding devices are also known from the prior art, in which, with a suitable actuator, the holding device can be released to remove the bending tool or closed to fix the bending tool. For example, hydraulic, pneumatic, or electromechanical actuators are used as actuators. Automatic holding devices relieve the human operator, but result in high manufacturing costs and are prone to errors.

[0005] DE 30 26 847 A1 discloses a press brake in which a bending tool is releasably clamped in a tool holder via a hydraulically or pneumatically pressurisable swellable body. DE 195 13 576 A1 discloses a bending press with a clamping device for the releasable fastening of a tool, wherein the clamping device is hydraulically operable.

[0006] WO 2015/164483 A1 describes a tool holder in which the tool is fixed using a clamping device that is actuated by a cylinder pressurised with compressed air.

[0007] Document US 2011/247389 A1 discloses a clamping device for clamping a tool in a press brake according to the preamble of claim 1. The clamping device includes a part receiving the tool as well as an actuated member and an engaging member to be brought into contact with the tool. The clamping device is provided with a transmission placed between the actuated member and the engaging member. The actuated member can be pneumatically or electrically or hydraulically driven. The transmission can include a wedge-shaped member or a lever.

[0008] Document WO 2020/225761 A1 discloses a bending machine for metal sheets comprising a punch means which includes an upper tool-holding cross piece. The cross piece comprises a locking means having a plurality of movable locking elements and configured to engage and lock upper bending tools in a locking configuration so as to prevent any movement of the upper bending tools. The locking elements are driven linearly between the locking configuration and a releasing configuration in which the locking elements do not engage and lock the upper bending tools.

[0009] The object of the invention is to provide a bending machine having a holding device for bending tools, wherein the holding device enables an automatic fixing and release of the bending tools in a simple manner.

[0010] This object is achieved by the bending machine according to patent claim 1. Further developments of the invention are defined in the dependent claims.

[0011] The bending machine according to the invention has a bending beam which can be moved in at least one working direction of the bending machine to form a workpiece by bending along a bending line, wherein the bending line runs in a width direction of the bending machine. The bending machine contains a holding device for fixing at least one bending tool on the bending machine. A release means is also provided on the bending machine which, when it is actuated, transfers the holding device from a closed position in which the at least one bending tool is fixed to an open position in which the at least one bending tool is released. The bending machine according to the invention is designed such that a movement of the bending beam towards a predetermined release position actuates the release means when the predetermined release position is reached.

[0012] The bending machine according to the invention has the advantage that the movement of the bending beam is used not only for the purposes of the bending of the workpiece, but also to release bending tools held in the bending machine. In this way, a simple mechanism is created to allow a changing of bending tools on the bending machine.

[0013] In a preferred embodiment of the bending machine according to the invention, the at least one bending tool is held on the bending beam when the holding device is in the closed position. Nevertheless, it is also possible that the at least one bending tool is held on a bending beam other than the bending beam, the movement of which actuates the release means.

[0014] The at least one bending tool can be fixed in different ways depending on the design of the bending machine. In a preferred variant, the holding device provided in the bending machine is designed for fixing the at least one bending tool in a positive and/or non-positive manner. A form-fitting fixing can be effected, for example, via a slide control. In the case of a non-positive fixing, the holding device exerts a holding force on the at least one bending tool to fix same on the bending machine, wherein the holding force on the at least one bending tool is terminated when the release means is actuated and the holding device is thereby brought into the open position in which the at least one bending tool is released.

[0015] In a further embodiment, the bending machine according to the invention is designed such that when the predetermined release position is reached, the movement of the bending beam generates a release force which is exerted on the holding device by the release means to cancel the fixing of the at least one bending tool. This variant of the invention is preferably combined with a non-positive fixing of the at least one bending tool, so that the release force terminates the holding force exerted by the holding device on the at least one bending tool.

[0016] In a variant of the embodiment just described,

the release means can generate the release force directly by mechanical action on the holding device. Nevertheless, it is also possible for the release means to comprise a hydraulic circuit, for example, which is switched on when the release position is reached and then generates the release force via hydraulic pressure.

[0017] In a further preferred embodiment, the bending machine according to the invention is designed such that the movement of the bending beam towards the predetermined release position is a movement in the working direction of the bending machine. This embodiment is preferably used when the bending machine is a press brake. In a modified embodiment it is also possible that the movement of the bending beam towards the predetermined release position is a movement in a direction deviating from the working direction, wherein the deviating direction preferably corresponds to the width direction of the bending machine. This variant is preferably used when the bending machine is a panel bender.

[0018] In a further embodiment, the release means is immovably attached to the bending machine, whereas the holding device together with the bending beam can be moved towards the predetermined release position. With this variant, the interaction of the release means with the holding device is implemented in a simple manner. The holding device is preferably provided on the bending beam, the movement of which actuates the release means, to hold the at least one bending tool on this bending beam. Nevertheless, instead of the holding device, the release means can also be movable with the bending beam, the movement of which actuates the release means, whereas the holding device is immovably attached to the bending machine to hold the at least one bending tool on a (stationary) bending beam other than the bending beam, the movement of which actuates the release means.

[0019] In a further variant of the bending machine according to the invention, the release means contains one or more contact elements, preferably one or more wedges. These contact elements are arranged such that when the predetermined release position is reached, they mechanically contact the holding device and thereby terminate the fixing of the at least one bending tool. With this variant, the release of the at least one bending tool can be achieved by a simple mechanical structure. In a preferred embodiment, the exertion of a holding force generated by the holding device on the at least one bending tool is terminated by means of the contact element or elements.

[0020] In a preferred variant, a respective contact element is designed such that when the predetermined release position is reached, it presses against at least one contact surface of the holding device and in this way triggers a movement on the holding device, whereby the fixing of the at least one bending tool is terminated. The exertion of a holding force generated by the holding device on the at least one bending tool is preferably terminated.

[0021] In a further preferred configuration, the holding device is a clamping device which is designed so as to exert a holding force in the form of a clamping force on the at least one bending tool to fix the at least one bending tool.

[0022] In a further preferred embodiment, the holding device comprises one or more elastic means, which are pretensioned in the holding device to generate thereby a holding force for fixing the at least one bending tool. The elastic means can be configured differently, for example as one or more springs, such as for example disc springs, and/or as one or more elastomers and the like.

[0023] To ensure that the at least one bending tool does not fall out of the holding device when in the open position, in a preferred variant the holding device comprises one or more loss prevention devices to hold the at least one bending tool loosely in the holding device when the holding device is open.

[0024] To ensure a correct alignment of the at least one bending tool when it is fixed, in a further variant the holding device comprises one or more positioning means to ensure that the at least one bending tool moves into a predetermined position when the predetermined release position is reached, in which the at least one bending tool is held by the holding device.

[0025] In a further variant, a sensor system is provided in the bending machine according to the invention, which is configured to detect the approach of the bending beam towards the predetermined release position as a detection event. The bending machine is preferably designed such that when the detection event is detected, a message is output via a user interface of the bending machine, such as for example a display. In this way, an operator of the bending machine is informed that the bending machine is in a state in which the bending tools can be changed.

[0026] In a further embodiment of the bending machine according to the invention, the release means can be moved into a parked position on the bending machine, in which the release means cannot be actuated by moving the bending beam. In this way, an unintentional loosening of the fixing of the at least one bending tool can be prevented.

[0027] In one embodiment, the bending machine according to the invention is a press brake for freely bending a workpiece between a movable upper beam and a stationary lower beam. The bending beam, the movement of which actuates the release means, is the upper beam.

[0028] In a particularly preferred variant of the bending machine designed as a press brake, the holding device is provided on the upper beam to hold the at least one bending tool on the upper beam, wherein the release means is arranged to be immovably adjacent to the upper beam and the predetermined release position is reached due to the movement of the upper beam in the working direction away from the lower beam. As a result, the movement of the upper beam that is already present

for bending the workpiece is also used to release the at least one bending tool in a simple manner.

[0029] In a further embodiment, the bending machine according to the invention is a panel bender, which is configured such that the workpiece-in contrast to free bending in a press brake-is fixed during bending.

[0030] In a particularly preferred variant of the bending machine designed as a panel bender, the holding device is provided on the bending beam, the movement of which actuates the release means to hold the at least one bending tool on this bending beam, wherein the predetermined release position is outside a working area in which the bending by the bending beam takes place. In this case, the bending beam can preferably be moved into the predetermined release position in the width direction of the panel bender.

[0031] In a preferred embodiment of the panel bender described above, this includes a primary bending beam, which is movable exclusively in the working direction and perpendicular to the plane spanned by the working direction and the width direction, and a secondary bending beam, which is the bending beam, the movement of which actuates the release means, wherein the secondary bending beam is movably arranged on the primary bending beam in the width direction. The secondary bending beam thus follows the movement of the primary bending beam, but can also be moved in the width direction relative to the primary bending beam.

[0032] In a preferred embodiment, the primary bending beam comprises one or more bending tools which are firmly connected thereto and cannot be exchanged without additional aids. In contrast, corresponding bending tools can be changed on the secondary bending beam. The secondary bending beam is therefore always used as required when bending processes must be carried out on the workpiece with specific bending tools.

[0033] Exemplary embodiments of the invention are described in detail below with reference to the accompanying figures.

[0034] In the figures:

Fig. 1 shows a first embodiment of a bending machine according to the invention in the form of a press brake in a plan view from the front;

Fig. 2 shows a perspective view of the press brake of Fig. 1;

Fig. 3 shows the press brake from Fig. 1 in a plan view from the rear;

Figs. 4 and 5 show detailed sectional views of the holding device from the bending machine of Fig. 1 in a closed state, in which the bending tool is fixed in the holding device;

Figs. 6 and 7 show sectional detail views of the holding device from the bending machine of Fig. 1 in an open state, in which the bending tool in the holding device is released by the release means;

Fig. 8 shows a perspective view of a second embodiment of a bending machine according to the invention in the form of a panel bender;

Fig. 9 shows a detailed plan view illustrating the mechanism for moving the secondary bending beams in the panel bender of Fig. 8;

Fig. 10 shows a detail view from Fig. 1 showing the holding device and the release means for the left-hand secondary bending beam of the panel bender from Fig. 8;

Fig. 11 shows a plan view of the left-hand secondary bending beam from Fig. 10 with the holding device closed;

Fig. 12 shows a sectional view through the left-hand secondary bending beam from Fig. 10 with the holding device closed;

Fig. 13 shows a plan view of the left-hand secondary bending beam from Fig. 10 with the holding device open; and

Fig. 14 shows a sectional view through the left-hand secondary bending beam from Fig. 10 with the holding device open.

[0035] In all of the figures described below, the spatial orientation of the corresponding bending machine is illustrated by a Cartesian coordinate system with an x-axis, y-axis and z-axis. The z-axis represents the height direction, the y-axis represents the width direction of the bending machine in which the bending line runs, and the x-axis represents the direction perpendicular to the y-axis and z-axis. In the direction of the x-axis, the workpiece to be bent is introduced into the bending machine by an operator or, in some cases, automatically.

[0036] A first embodiment of a bending machine according to the invention in the form of a press brake is described below. This press brake is shown in plan view in Fig. 1 and in perspective view in Fig. 2 and is indicated by the symbol 100. Only the components of the press brake that are essential to the invention are shown.

[0037] The press brake 100 comprises a machine body 101 fixed to the floor, which comprises two side stands 102, 103 and a front plate 104. A stationary lower beam 106 and an upper beam 105 that can be moved in the z-

direction extend in a manner known per se between the side stands 102 and 103. In the embodiment described here, the upper beam represents a bending beam within the meaning of the claims. On the upper side of the lower beam 106 there is a tool holder 107, on which suitable lower tools are fastened during operation of the bending machine. Analogously, bending tools are fixed to the underside of the upper beam 105 for the corresponding bending process, wherein two such bending tools 109 are provided according to Figs. 1 and 2.

[0038] The press brake 100 is used for bending sheet metal. The sheet metal is introduced along the x-axis into the working area between lower beam 106 and upper beam 105, and then the upper beam 105 is moved downwards to form the sheet metal, so that the bending tools 109 press into the sheet metal and form it appropriately. The movement of the upper beam 105 is effected by means of hydraulics in the form of two hydraulic cylinders 112, 112', which can be seen from the rear view of Fig. 3. To control and monitor the bending process carried out by the press brake are provided a control device 110, indicated only schematically in Fig. 1, and a user interface 111 in the form of a touch display, which is arranged in the right-hand area of the press brake on the front plate 104.

[0039] Since large forces act on the sheet during the bending process, the corresponding bending tools 109 must be firmly fixed in the upper beam 105. At the same time, however, it must also be ensured that the bending tools 109 can be exchanged. This is ensured by a holding device 113 which fixes the corresponding bending tools 109 to the upper beam 105, wherein it is possible for the holding device to be opened with a release means 116 to remove the bending tools.

[0040] The construction and functioning of the holding device 113 and the release means 116 are explained in more detail below with reference to Figs. 3 to 7. Fig. 3 shows a press brake 100 in a plan view from the rear. Fig. 3 shows the already mentioned hydraulic cylinders 112 and 112', which act in a manner known per se on the edge regions of the upper beam 105 and thereby move the upper beam up or down. Fig. 3 also shows the above-mentioned holding device 113, which in the embodiment described here is designed as a clamping device. The holding device 113 comprises a clamping plate 114 which extends along the width direction y of the press brake and, in the closed state, exerts a clamping force on the bending tools 109 in the direction of the x-axis. The clamping plate is held on the lower end of the upper beam 105 by a large number of fastening means 115 in the form of screws. For reasons of clarity, only some of these fastening means are labelled with reference symbol 115.

[0041] A release means 116 is used to open the holding device 113 and thereby release the fixing of the bending tools 109 in the holding device, which in the embodiment described here includes a total of eight contact elements 117 in the form of corresponding wedges which are fastened along the y-direction to a transverse strut 118, which in turn is attached to the machine body 101 via fastening means 119 in the form of screws. The transverse strut, which is located adjacent to the upper beam 105 in the x-direction, is thus arranged in a stationary manner on the press brake 100 and consequently cannot be moved together with the upper beam. When the upper beam 105 moves upwards, the contact elements 117 penetrate the holding device 113, as a result of which the latter is opened and the clamping of the bending tools 109 is released, as will be described in more detail below.

[0042] Fig. 3 also shows a sensor system 108 that is indicated only schematically. This sensor system detects when the contact elements 117 are in a position within the holding device 113 due to an upward movement of the upper beam 105, so that the clamping of the bending tools 109 is released. When this position is detected, a corresponding message is generated on the user interface 111 so that the operator knows that the bending tool 109 is now released and can be removed. In the same way, a message can be output via the user interface 111 if the sensor system 108 detects that, due to the downward movement of the upper beam 105, the contact elements 117 have moved so far out of the holding device 113 that they can no longer effect the opening of the holding device 113, and the bending tools 109 are fixed to the upper beam 105. The corresponding message shows the user that the corresponding bending process can now be carried out.

[0043] Fig. 4 and Fig. 5 show sectional views in the closed state of the holding device 113, wherein the section in Fig. 4 in the xz-plane runs centrally through the left-hand bending tool 109 in Fig. 3, whereas the section in Fig. 5 in the xz-plane runs centrally through the left-most wedge 117 of Fig. 3. As can be seen from Figs. 4 and 5, the contact element 117 is fastened to the transverse strut 118 via fastening means in the form of screws 120. At lower end thereof, the contact element 117 has a wedge-shaped tip which is moved into the holding device 113 to open it, as will be described in more detail further below.

[0044] The holding device 113 comprises the clamping plate 114, which is formed from a front section 114a and a rear section 114b, which are firmly connected to one another, for example via a screw connection. The rear section 114b is arranged in a recess at the lower end of the upper beam 105 and is held there together with the front section 114a via the fastening means 115 on the upper beam 105 already mentioned above. In the embodiment described here, the fastening means 115 is a screw which extends from an opening in the front section 114a of the clamping plate 114 through a bore in the rear section 114b of the clamping plate 114 into a threaded bore in the upper beam 105. The screw comprises a rear threaded section 115b, which is screwed to the upper beam 105, and a cylindrical section 115a, on which is arranged an elastic means 121 which is formed from plate fields in the embodiment described here. Furthermore, the fastening means 115 has a head 115c which

presses against the elastic means 121 so that a pretensioning force is generated. This pretensioning force presses the rear section 114b of the clamping plate 114 against the bending tool 109, which is accommodated in a gap between the upper beam 105 and the rear section 114b. As a result, the bending tool 109 is fixed in the holding device 113.

[0045] The correct positioning of the bending tool 109 in the holding device 113 is achieved with the aid of a positioning means 123 in the form of an adjusting wedge, the triangular tip of which engages in a corresponding recess 125 in the bending tool 109. When the holding device 113 is closed, this adjusting wedge slides into the recess 125 and thus ensures that the bending tool 109 is correctly arranged on the upper beam 105. In addition, at the upper end of the bending tool 109 there is a loss prevention device 122 in the form of a tongue or groove, into which an undercut 124 of the bending tool 109 engages. When the holding device 113 is opened, in which the rear section 114a of the clamping plate 114 moves away from the bending tool 109, the engagement of the loss prevention device 122 in the undercut 124 ensures that the bending tool 109 is lodged on the upper beam 105. Subsequently, the bending tool 109 can be removed from the upper beam 105 manually by an operator via a corresponding tilting movement.

[0046] It can be seen from Fig. 5 that in the sections of the clamping plate 114 on which a corresponding contact element 117 is located, a pocket 129 is formed between the front section 114a and the rear section 114b of the clamping plate. In the area of this pocket there is also an opening in the rear clamping plate 114b, in which a contact block 126 with a bevelled contact surface 128 is inserted. The contact surface 128 comes into contact with the contact element 117. Furthermore, an inclined contact surface 127 for the contact element 117 is provided on the front section 114a. When the holding device 113 is opened, the contact element 117 is inserted into the pocket 129 from above, wherein the contact element 117 is not yet inserted so deeply in the state of Figs. 4 and 5 that the holding device is opened.

[0047] Fig. 6 shows a sectional view analogous to Fig. 4 with the holding device 113 open. In the same way, Fig. 7 shows a sectional view analogous to Fig. 5 with the holding device 113 open. To open the holding device 113, the upper beam 105 is moved a little further upwards compared to Figs. 4 and 5, so that the contact elements 117 penetrate deeper into the corresponding pockets 129 compared to Figs. 4 and 5. As a result, the clamping plate 114 is moved to the right, whereby the elastic means 121 is compressed and thereby the clamping force acting on the bending tool 109 is released. The release means thus generates a release force acting against the clamping force.

[0048] As can be seen from Fig. 6 and Fig. 7, when the holding device 113 is in the open position, the rear section 114b of the clamping plate 114 no longer presses against the bending tool 109. Consequently, the bending tool 109 is only loosely held on the upper beam 105 by the loss prevention device 122 and can be exchanged by an operator. To fix the exchanged bending tool, the upper beam 105 is moved down again, which means that the contact elements 117 move out of the respective pockets 129 and the clamping plate 114 presses against the bending tool 109 again via the elastic means 121, thereby fixing it. A corresponding bending process can then be effected by moving the upper beam 105 further down towards the workpiece which is located between the upper beam 105 and the lower beam 106.

[0049] A second embodiment of a bending machine according to the invention is described below with reference to Figs. 8 to 14. This bending machine is denoted by reference number 200 in the perspective view of Fig. 8. This is what is termed a panel bender, which is used to bend metal sheets in the same way as press brakes, wherein unlike press brakes, the metal sheets are fixed during the bending process.

[0050] The panel bender 200 comprises a machine body 201, which has two side stands 202 and 203, among other things. An upper hold-down device 230, which can be moved in the vertical direction, and a stationary lower hold-down device 232 extend between the side stands. A hold-down tool 231 is provided at the lower end of the upper hold-down device 230. Analogously, a hold-down tool 233 is provided at the upper end of the lower hold-down device 232. For a bending process, the workpiece or sheet metal to be bent is fixed between the two hold-down tools 231 and 233. For this purpose, the upper hold-down device 230 moves downwards so that the workpiece is clamped between the hold-down devices 231 and 233. The movement of the upper hold-down device 230 is preferably effected via hydraulics, which cannot be seen from the figures.

[0051] A primary bending beam 234 and two secondary bending beams 205, 205' are provided in the panel bender 200 for bending the sheet metal fixed between the hold-down tools 231 and 233. A respective secondary bending beam represents a bending beam within the meaning of the patent claims. The primary bending beam 234 extends along the hold-down devices 230 and 232 in the width direction (i.e., the y-direction) of the panel bender. An upper bending tool 235 and a lower bending tool 236 are permanently attached to the primary bending beam, i.e., these bending tools cannot be exchanged without additional aids. The primary bending beam 234 can be moved in the z-direction and the x-direction and can thereby use the bending tools 235 and 236 to bend the sheet metal that is fixed between the hold-down tools 231 and 233.

[0052] To carry out specific bending processes, the two secondary bending beams 205, 205' are used in the panel bender 200. These bending beams are arranged on the primary bending beam 234 and follow the movement of the primary bending beam in the x-and z-directions. In addition, the secondary bending beams 205, 205' can be moved in the y-direction relative to the

primary bending beam 234. Corresponding extension sections 237 and 237' in the form of profiles are attached on each side of the primary bending beam 234, wherein the secondary bending beam 205 can be driven into the extension section 237 and the secondary bending beam 205' can be driven into the extension section 237'. According to Fig. 8, the secondary bending beams 205, 205' are also located in the extension sections 237, 237'. The movement of the secondary bending beams 205, 205' relative to the primary bending beam 234 is effected via belt drives which comprise rotary drives 240, 240', deflection rollers 241, 241' and toothed belts 238, 238'. The structure of the belt drives is explained in more detail below with reference to Fig. 9.

[0053] In contrast to the primary bending beam 234, corresponding bending tools are fastened to the secondary bending beams 205, 205' in an exchangeable manner. Two bending tools 209 are shown as an example in Fig. 8, which are held on the secondary bending beam 205 or on the secondary bending beam 205' via holding devices 213, which are described further below. To bend a metal sheet, the secondary bending beam 205 or 205' can be moved into the primary bending beam 234 by the extension sections 237 or 237'. The movement of the primary bending beam 234 can then cause the corresponding secondary bending beam to also move and the bending tools 209 to interact with the metal sheet. After completion of the bending process, the secondary bending beam used is moved back into the extension section 237 or 237'. When a respective secondary bending beam 205, 205' is moved into a specific tool change position within the extension sections 237, 237', a release means 216 (see Fig. 10) interacts with the holding device 213, whereby the bending tools 209 are released from the holding device 213 as described in more detail below.

[0054] Fig. 9 shows the structure of the primary bending beam 234 and the secondary bending beams 205, 205' in a plan view from the front. To move the secondary bending beam 205 from the corresponding extension section 237 into the primary bending beam 234, use is made of the upper rotary drive 240 which drives the toothed belt 238, which is deflected via the deflection roller 241 and guided back to the rotary drive 240. The secondary bending beam 205 is connected to the toothed belt 238, so that the movement of the toothed belt causes the movement of the secondary bending beam in the y-direction via the rotary drive 240. Analogously, the lower rotary drive 240' is provided for moving the secondary bending beam 205', which is deflected back to the rotary drive 240' via the deflection roller 241'. The toothed belt 238' is connected to the secondary bending beam 205', so that the movement of the toothed belt leads to the movement of the secondary bending beam 205' in the y-direction. For the movement of the bending beams 205 and 205', two guide rails 250 are provided, which extend over the length of the primary bending beam 234 and the two extension sections 237, 237'.

[0055] Fig. 10 shows a perspective detailed view of the area of the left secondary bending beam 205 from Fig. 8. As can be seen, the secondary bending beam 205 has a U-shaped profile which is incorporated into a corresponding U-shaped profile of the extension section 237. The secondary bending beam 205 is slidably guided along the guide rails 250 via two upper and two lower guide carriages 249 (see Figs. 11 to 14). Fig. 10 also shows that two holding devices 213 (an upper and a lower holding device) are provided for the secondary bending beam 205, each of which comprises a front clamping bar 243, via which bending tools are clamped to the secondary bending beam 205.

[0056] In addition, the release means 216, which is not visible per se and which opens the corresponding holding device, is shown with dashed lines for both holding devices 213. The release means for the upper holding device comprises two contact elements 217 in the form of wedges which are fastened and in particular screwed to the underside of the upper leg of the extension section 237. Furthermore, a wedged strip 242 is provided, which is movably arranged between the upper leg of the extension section 237 and the upper leg of the bending beam 205. The wedged strip 242 interacts with the contact elements 217, as will be described further below. Corresponding contact elements 217 in the form of wedges are also provided on the upper side of the lower leg of the extension section 237, which in turn interact with a wedged strip 242, which is movably arranged between the lower leg of the extension section 237 and the lower leg of the bending beam 205.

[0057] Figs. 11 and 12 show in detail the structure of the upper holding device 213 and the associated release means 216 of the bending beam 205 in a state in which the bending tool 209 is fixed by the holding device 213. Fig. 11 shows a plan view of a plane in which are located the two contact elements 217 and the wedged strip 242 for the upper holding device. The secondary bending beam 205 is in a position which is outside of the primary bending beam 234, but does not yet correspond to a release position further to the left in Fig. 11, in which the holding device 213 is open. As can be seen from Fig. 11, the wedged strip 242 has two inclined contact surfaces 227 which, in the position shown in Fig. 11, do not yet interact with opposite inclined surfaces of the contact elements 217. In addition to the front clamping bar 243, Fig. 11 shows several fastening means 244 in the form of screws, several elastic means 221 in the form of disc springs, a rear clamping bar 247 and further fastening means 246. These components are described below with reference to Fig. 12.

[0058] Fig. 12 shows a section in the xz-plane from Fig. 11 at the position of the bending tool 209. As can be seen, the fastening means 244 is screwed to a holding means 245 in the form of a cylindrical pin, with the holding means 245 in turn being inserted into a bore in the wedged strip 242 and thereby producing a rigid connection via the further fastening means 246 between the wedged strip 242 and the holding means 245. The holding means 245

holds the wedged strip 242 between the upper leg of the extension section 237 and the lower leg of the bending beam 205. In addition, it can be seen in Fig. 12 that the rear clamping bar 247 is located behind the front clamping bar 243 and is firmly connected to the upper leg of the bending beam 205, for example via a screw connection. The rear clamping bar 247 has a bore in which there is a socket 248 through which the holding means 248 extends. The socket and a section on the back of the rear clamping bar 247 press against the elastic means 221 in the form of disc springs. A section of the elastic means 221 is arranged in a receptacle of the clamping bar 242, so that the clamping bar 242 constitutes an abutment for the elastic means 221, which is placed under pretensioning force.

[0059] The distance between the front clamping bar 243 and the rear clamping bar 242 is so small in Fig. 12 that the bending tool 209 is clamped between the two clamping bars. Similar to the first embodiment described above, a positioning means 223 in the form of an adjusting wedge is again provided, which engages in a corresponding recess 225 of the bending tool 209. Furthermore, just as in the first embodiment, a loss prevention device 222 is provided in the form of a tongue or groove, into which an undercut 224 of the bending tool 209 engages.

[0060] To release the fixing of the bending tool 209 in the holding device 213, the secondary bending beam 205 is moved further to the left in the y-direction until it reaches the release position shown in Figs. 13 and 14. Fig. 13 shows a plan view analogous to Fig. 11 and Fig. 14 shows a section analogous to Fig. 12. As can be seen from Fig. 13, when the release position is reached, the front inclined section of the corresponding contact elements 217 interacts with the opposite inclined contact surfaces 227 of the wedged strip 242. As a result, under compression of the elastic means 221, the wedged strip 242 slides forward together with the holding means 245 and the front clamping bar 243 (i.e., to the right in the sectional view of Fig. 14), thereby enlarging the distance between the front clamping bar 243 and the rear clamping bar 247, and the clamping of the bending tool 209 in the holding device 213 is thereby released. The bending tool 209 is still held in the holding device via the loss prevention device 222, but can be removed from the holding device by an operator via a corresponding tilting movement.

[0061] Embodiments of a bending machine have been described above, in which the fixing of the bending tools in a corresponding holding device is ensured via an elastic means and this fixing is released in a purely mechanical manner by generating a corresponding release force. Nevertheless, it is also possible for the bending tools to be fixed in some other way, for example hydraulically, and for the corresponding release force to release the fixing also to be generated hydraulically.

[0062] If hydraulic clamping is used in the panel bender described above instead of mechanical clamping, this has the disadvantage that hydraulic hoses, for example via energy chains, must be routed over the entire bending length. To avoid this disadvantage, a hydraulic clamping bar having a closed hydraulic circuit can be used. The secondary bending beam has two positions, a parked position and a tool change position. The bending tool is still clamped in the parked position, whereas this clamping is released in the tool change position. In the tool change position, a quick-release coupling of the otherwise self-sufficient hydraulic circuit of the clamp is connected to a controlled circuit and the pressure of the clamp for disengaging or clamping the bending tools is controlled directly. A hydraulic pump can also be provided for this.

[0063] If the secondary bending beam is in the parked position, the hydraulic pressure in the self-sufficient hydraulic circuit is constant and the bending tools are held in the clamping unit. There is no connection to the controlled hydraulic circuit. If the secondary bending beam is moved to the tool change position, it is coupled to the controllable hydraulic circuit via the quick coupling. The hydraulic pressure in the controlled hydraulic circuit can then be reduced thereby to effect release of the clamp. On the other hand, the pressure for effecting the clamping is increased again. If the secondary bending beam is then moved from the tool change position to the parked position after a tool change, the controllable hydraulic circuit is decoupled again, wherein a non-return valve keeps the pressure within the clamp constant. The clamping is then self-sufficient again.

[0064] The embodiments of the invention described in the foregoing provide a number of advantages. In particular, an already existing movement of a bending beam in a bending machine is also used in a simple manner to open a holding device to thereby release bending tools fixed in the holding device. A release position for the movable bending beam is defined, wherein a movement of the bending beam towards the release position actuates a corresponding release means when the release position is reached, to thereby open the holding device. The invention can be used for various types of bending machines. In particular, it can be used both in press brakes for free bending of workpieces, and in panel benders where the workpiece is fixed during the bending process.

List of reference symbols

[0065]

100 Bending machine (press brake)
101 Machine body
102, 103 Side stands
104 Front plate
105 Bending beam (upper beam)
106 Lower beam
107 Tool holder
108 Sensor system
109 Bending tools

110 Control device
111 User interface (display)
112, 112' Hydraulic cylinder
113 Holding device (clamping device)
114 Clamping plate
114a Front section of 114
114b Rear section of 114
115 Fastening means (screw) for 114
115a Cylindrical section of 115
115b Threaded section of 115
115c Head of 115
116 Release means
117 Contact elements (wedges)
118 Transverse strut
119 Fastening means (screws) for 118
120 Fastening means (screw) for 117
121 Elastic means (disc springs)
122 Loss prevention device (spring)
123 Positioning means (adjusting wedge)
124 Undercut
125 Recess
126 Contact block
127 Bearing surface of 114a
128 Contact area of 126
129 Pocket
200 Bending machine (panel bender)
201 Machine body
202, 203 Side stands
205 Bending beam (secondary bending beam)
205' Bending beam (secondary bending beam)
209 Bending tools
213 Holding device (clamping device)
216 Release means
217 Contact elements (wedges)
221 Elastic means (disc springs)
222 Loss prevention device (spring)
223 Positioning means (adjusting wedge)
224 Undercut
225 Recess
227 Contact surface of 242
230 Upper hold-down device
231 Hold-down tool
232 Lower hold-down device
233 Hold-down tool
234 Primary bending beam
235 Upper bending tool
236 Lower bending tool
237, 237' Extension sections
238, 238' Toothed belt
240, 240' Rotary drives
241, 241' Deflection rollers
242 Wedged strip
243 Front clamping bar
244 Fastening means (screw) for 243
245 Holding means (cylindrical pin) for 242
246 Fastening means for 242
247' Rear clamping bar
248 Socket
249 Guide carriage
250 Guide rails

Claims

1. A bending machine, the bending machine (100; 200) having a bending beam (105; 205, 205') which can be moved at least in one working direction (z) of the bending machine (100; 200) to form a workpiece by bending along a bending line which runs in a width direction (y) of the bending machine (100; 200), the bending machine (100; 200) containing a holding device (113; 213) to mount at least one bending tool (109; 209) on the bending machine (100; 200), and a release means (116; 216) being provided on the bending machine (100; 200) to move the holding device (113; 213) from a closed position in which the at least one bending tool (109; 209) is fixed into an open position releasing the at least one bending tool (109; 209),
characterised in that
the bending machine (100; 200) is designed such that a movement of the bending beam (105; 205, 205') towards a predetermined release position actuates the release means (116; 216) when the predetermined release position is reached.

2. The bending machine according to claim 1, **characterised in that** the holding device (113; 213) is designed to fix the at least one bending tool (109; 209) in a positive and/or non-positive manner.

3. The bending machine according to claim 1 or 2, **characterised in that** the bending machine (100; 200) is designed such that the movement of the bending beam (105; 205, 205') when the predetermined release position is reached generates a release force which is exerted by means of the release means (116; 216) on the holding device (113; 213) to cancel the fixing of the at least one bending tool (109; 209).

4. The bending machine according to any one of the preceding claims, **characterised in that** the bending machine (100; 200) is designed such that the movement of the bending beam (105; 205, 205') towards the predetermined release position involves a movement in the working direction (z) or in a direction deviating from the working direction (z), wherein the deviating direction preferably corresponds to the width direction (y) of the bending machine (100; 200).

5. The bending machine according to any one of the preceding claims, **characterised in that** the release means (116; 216) is immovably attached to the bending machine (100; 200), whereas the holding

device (113; 213) together with the bending beam (105; 205, 205') can be moved towards the predetermined release position, wherein the holding device (113; 213) is preferably provided on the bending beam (105; 205, 205') to hold the at least one bending tool (109; 209) on the bending beam (105; 205, 205').

6. The bending machine according to any one of the preceding claims, **characterised in that** the release means (116; 216) contains one or more contact elements (117; 217), preferably one or more wedges, which are arranged such that they release the holding device (113; 213) when the predetermined release position is mechanically contacted, and thereby terminate the fixing of the at least one bending tool (109; 209).

7. The bending machine according to claim 6, **characterised in that** a respective contact element (117; 217) is designed such that when it reaches the predetermined release position it presses against at least one contact surface (127; 227) of the holding device (113; 213) and thereby triggers a movement of the holding device (113; 213), as a result of which the fixing of the at least one bending tool (109; 209) is terminated.

8. The bending machine according to any one of the preceding claims, **characterised in that** the holding device (113; 213) is a clamping device which is designed such that to fix the at least one bending tool (109; 209), it exerts a holding force in the form of a clamping force on the at least one bending tool (109; 209).

9. The bending machine according to any one of the preceding claims, **characterised in that** the holding device (113; 213) comprises one or more elastic means (121; 221) which are pretensioned in the holding device (113; 213) to thereby generate a holding force for fixing the at least one bending tool (109; 209).

10. The bending machine according to any one of the preceding claims, **characterised in that** the holding device (113; 213) comprises one or more loss prevention devices (122; 222) to hold the at least one bending tool (109; 209) loosely in the holding device (113; 213) when the holding device (113; 213) is open, and/or one or more positioning means (123; 223) to ensure that when the predetermined release position is reached, the at least one bending tool (109; 209) moves into a predetermined position in which the at least bending tool (109; 209) is held by the holding device (113; 213).

11. The bending machine according to any one of the preceding claims, **characterised in that** a sensor system (108) is provided in the bending machine (100; 200), which is configured to detect the approach of the bending beam (105; 205, 205') towards the predetermined release position as a detection event, wherein the bending machine (100; 200) is preferably configured such that when the detection event is detected, a message is output via a user interface (111) of the bending machine (100; 200).

12. The bending machine according to any one of the preceding claims, **characterised in that** the release means (116; 216) can be moved into a parked position on the bending machine in which the release means (116; 216) cannot be actuated by moving the bending beam (105; 205, 205').

13. The bending machine according to any one of the preceding claims, **characterised in that** the bending machine (100; 200) is a press brake (100) for freely bending a workpiece between a movable upper beam (105) and a stationary lower beam (106), wherein the bending beam (105; 205, 205') is the upper beam (105).

14. The bending machine according to claim 13, **characterised in that** the holding device (113; 213) is provided on the upper beam (105) to hold the at least one bending tool (109; 209) on the upper beam (105), and the release means (116; 216) is arranged to be immovably adjacent to the upper beam (105), wherein the predetermined release position is reached by the movement of the upper beam (105) in the working direction (z) away from the lower beam (106).

15. The bending machine according to any one of claims 1 through 12, **characterised in that** the bending machine (100; 200) is a panel bender (200) which is configured such that the workpiece is fixed during bending.

16. The bending machine according to claim 15, **characterised in that** the holding device (113; 213) is provided on the bending beam (105; 205, 205') to hold the at least one bending tool (109; 209) on the bending beam (105; 205, 205') and the predetermined release position is outside of a working area in which the bending by the bending beam (105; 205, 205') takes place, wherein the bending beam (113; 213) is preferably movable in the width direction (y) of the panel bender (200) in the predetermined release position.

Patentansprüche

1. Biegemaschine, wobei die Biegemaschine (100;

200) einen Biegebalken (105; 205, 205') aufweist, der mindestens in einer Arbeitsrichtung (z) der Biegemaschine (100; 200) bewegt werden kann, um ein Werkstück durch Biegen entlang einer Biegelinie zu bilden, die in einer Breitenrichtung (y) der Biegemaschine (100; 200) verläuft, wobei die Biegemaschine (100; 200) eine Haltevorrichtung (113; 213), um mindestens ein Biegewerkzeug (109; 209) an der Biegemaschine (100; 200) zu montieren, und Freigabemittel (116, 216) enthält, die an der Biegemaschine (100; 200) bereitgestellt sind, um die Haltevorrichtung (113; 213) aus einer geschlossenen Position, in der das mindestens eine Biegewerkzeug (109; 209) fixiert ist, in eine offene Position zu bewegen, in der das mindestens eine Biegewerkzeug (109; 209) freigegeben ist,
dadurch gekennzeichnet, dass
die Biegemaschine (100; 200) so ausgestaltet, dass eine Bewegung des Biegebalkens (105; 205, 205') in Richtung einer vorgegebenen Freigabeposition die Freigabemittel (116; 216) betätigt, wenn die vorgegebene Freigabeposition erreicht ist.

2. Biegemaschine nach Anspruch 1, **dadurch gekennzeichnet, dass** die Haltevorrichtung (113; 213) ausgestaltet ist, um das mindestens eine Biegewerkzeug (109; 209) in einer positiven und/oder nicht positiven Weise zu fixieren.

3. Biegemaschine nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Biegemaschine (100; 200) so ausgestaltet ist, dass die Bewegung des Biegebalkens (105; 205, 205'), Wenn die vorgegebene Freigabeposition erreicht ist, eine Freigabekraft erzeugt, die mittels der Freigabemittel (116; 216) auf die Haltevorrichtung (113; 213) ausgeübt wird, um das Fixieren des mindestens einen Biegewerkzeugs (109; 209) aufzuheben.

4. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Biegemaschine (100; 200) so ausgestaltet ist, dass die Bewegung des Biegebalkens (105; 205, 205') in Richtung der vorgegebenen Freigabeposition eine Bewegung in Arbeitsrichtung (z) oder in eine von der Arbeitsrichtung (z) abweichenden Richtung einbezieht, wobei die abweichende Richtung vorzugsweise der Breitenrichtung (y) der Biegemaschine (100; 200) entspricht.

5. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Freigabemittel (116; 216) unbeweglich an der Biegemaschine (100; 200) angebracht sind, während die Haltevorrichtung (113; 213) zusammen mit dem Biegebalken (105; 205, 205') in Richtung der vorgegebenen Freigabeposition bewegt werden kann, wobei die Haltevorrichtung (113; 213) vorzugsweise an dem Biegebalken (105; 205, 205') bereitgestellt ist, um das mindestens eine Biegewerkzeug (109; 209) an dem Biegebalken (105; 205, 205') zu halten.

6. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Freigabemittel (116; 216) ein oder mehrere Berührungselemente (117; 217), vorzugsweise einen oder mehrere Keile, enthält, die derart angeordnet sind, dass sie die Haltevorrichtung (113; 213) freigeben, wenn die vorgegebene Freigabeposition mechanisch berührt wird, und dadurch das Fixieren des mindestens einen Biegewerkzeugs (109; 209) aufheben.

7. Biegemaschine nach Anspruch 6, **dadurch gekennzeichnet, dass** ein jeweiliges Berührungselement (117; 217) so ausgestaltet ist, dass es bei Erreichen der vorgegebenen Freigabeposition gegen mindestens eine Berührungsoberfläche (127; 227) der Haltevorrichtung (113; 213) drückt und dadurch eine Bewegung der Haltevorrichtung (113; 213) auslöst, wodurch das Fixieren des mindestens einen Biegewerkzeugs (109; 209) aufgehoben wird.

8. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Haltevorrichtung (113; 213) eine Klemmvorrichtung ist, die so ausgestaltet ist, dass sie zum Fixieren des mindestens einen Biegewerkzeugs (109; 209) eine Haltekraft in Form einer Klemmkraft auf das mindestens eine Biegewerkzeug (109; 209) ausübt.

9. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Haltevorrichtung (113; 213) ein oder mehrere elastische Mittel (121; 221) umfasst, die in der Haltevorrichtung (113; 213) vorgespannt sind, um dadurch eine Haltekraft zum Fixieren des mindestens einen Biegewerkzeugs (109; 209) zu erzeugen.

10. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Haltevorrichtung (113; 213) eine oder mehrere Verliersicherungsvorrichtungen (122; 222), um das mindestens eine Biegewerkzeug (109; 209) lose in der Haltevorrichtung (113; 213) zu halten, wenn die Haltevorrichtung (113; 213) geöffnet ist, und/oder ein oder mehrere Positioniermittel (123; 223) umfasst, um sicherzustellen, dass, wenn die vorgegebene Freigabeposition erreicht ist, sich das mindestens eine Biegewerkzeug (109; 209) in eine vorgegebene Position bewegt, in der das mindestens eine Biegewerkzeug (109; 209) durch die Haltevorrichtung (113; 213) gehalten wird.

11. Biegemaschine nach einem der vorhergehenden

Ansprüche, **dadurch gekennzeichnet, dass** in der Biegemaschine (100; 200) ein Sensorsystem (108) bereitgestellt ist, das konfiguriert ist, um eine Annäherung des Biegebalkens (105; 205, 205') in Richtung der vorgegebenen Freigabeposition als Erkennungsereignis zu erkennen, wobei die Biegemaschine (100; 200) vorzugsweise so konfiguriert ist, dass, wenn das Erkennungsereignis erkannt wird, eine Nachricht über eine Benutzerschnittstelle (111) der Biegemaschine (100; 200) ausgegeben wird.

12. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Freigabemittel (116; 216) in eine Parkposition an der Biegemaschine bewegt werden können, in der die Freigabemittel (116; 216) nicht durch Bewegen des Biegebalkens (105; 205, 205') bewegt werden können.

13. Biegemaschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Biegemaschine (100; 200) eine Abkantpresse (100) zum freien Biegen eines Werkstücks zwischen einem beweglichen Oberbalken (105) und einem stationären Unterbalken (106) ist, wobei der Biegebalken (105; 205, 205') der Oberbalken (105) ist.

14. Biegemaschine nach Anspruch 13, **dadurch gekennzeichnet, dass** die Haltevorrichtung (113; 213) an dem Oberbalken (105) bereitgestellt ist, um das mindestens eine Biegewerkzeug (109; 209) an dem Oberbalken (105) zu halten, und die Freigabemittel (116; 216) Angeordnet sind, um dem Oberbalken (105) benachbart unbeweglich zu sein, wobei die vorgegebene Freigabeposition durch die Bewegung des Oberbalkens (105) in der Arbeitsrichtung (z) weg von dem Unterbalken (106) erreicht wird.

15. Biegemaschine nach einem der Ansprüche 1 bis 12, **dadurch gekennzeichnet, dass** die Biegemaschine (100; 200) eine Blechbiegemaschine (200) ist, die so konfiguriert ist, dass das Werkstück während des Biegens fixiert ist.

16. Biegemaschine nach Anspruch 15, **dadurch gekennzeichnet, dass** die Haltevorrichtung (113; 213) an dem Biegebalken (105; 205, 205') bereitgestellt ist, um das mindestens eine Biegewerkzeug (109; 209) an dem Biegebalken (105; 205, 205') zu halten, und die vorgegebene Freigabeposition sich außerhalb eines Arbeitsbereichs befindet, in dem das Biegen durch den Biegebalken (105; 205, 205') stattfindet, wobei der Biegebalken (113; 213) in der vorgegebenen Freigabeposition vorzugsweise in der Breitenrichtung (y) der Blechbiegemaschine (200) bewegbar ist.

Revendications

1. Machine à plier, la machine à plier (100 ; 200) comprenant une barre plieuse (105 ; 205, 205') qui peut être déplacée au moins dans un sens de travail (z) de la machine à plier (100 ; 200) pour former une pièce par pliage le long d'une ligne de pliage qui s'étend dans le sens de la largeur (y) de la machine à plier (100 ; 200), la machine à plier (100 ; 200) contenant un dispositif de retenue (113 ; 213) pour monter au moins un outil de pliage (109 ; 209) sur la machine à plier (100 ; 200), et un moyen de libération (116 ; 216) étant disposé sur la machine à plier (100 ; 200) pour déplacer le dispositif de retenue (113 ; 213), d'une position fermée dans laquelle l'au moins un outil de pliage (109 ; 209) est fixé à une position ouverte libérant l'au moins un outil de pliage (109 ; 209),
caractérisée en ce que
la machine à plier (100 ; 200) est conçue de telle sorte qu'un déplacement de la barre plieuse (105 ; 205, 205') vers une position de libération prédéterminée actionne le moyen de libération (116 ; 216) lorsque la position de libération prédéterminée est atteinte.

2. Machine à plier selon la revendication 1, **caractérisée en ce que** le dispositif de retenue (113 ; 213) est conçu pour fixer l'au moins un outil de pliage (109 ; 209) de manière positive et/ou non positive.

3. Machine à plier selon la revendication 1 ou 2, **caractérisée en ce que** la machine à plier (100 ; 200) est conçue de telle sorte que le déplacement de la barre plieuse (105 ; 205, 205'), lorsque la position de libération prédéterminée est atteinte, génère une force de libération qui est exercée au moyen du moyen de libération (116 ; 216) sur le dispositif de retenue (113 ; 213) pour annuler la fixation de l'au moins un outil de pliage (109 ; 209).

4. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la machine à plier (100 ; 200) est conçue de telle sorte que le déplacement de la barre plieuse (105 ; 205, 205') vers la position de libération prédéterminée implique un déplacement dans le sens de travail (z) ou dans un sens déviant du sens de travail (z), dans laquelle le sens déviant correspond de préférence au sens de la largeur (y) de la machine à plier (100 ; 200).

5. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le moyen de libération (116 ; 216) est fixé à demeure à la machine à plier (100 ; 200), tandis que le dispositif de retenue (113 ; 213) peut être déplacé conjointement avec la barre plieuse (105 ; 205, 205') vers la

position de libération prédéterminée, dans laquelle le dispositif de retenue (113 ; 213) est de préférence disposé sur la barre plieuse (105 ; 205, 205') pour retenir l'au moins un outil de pliage (109 ; 209) sur la barre plieuse (105 ; 205, 205').

6. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le moyen de libération (116 ; 216) contient un ou plusieurs éléments de contact (117 ; 217), de préférence une ou plusieurs cales, qui sont disposées de telle sorte qu'elles libèrent le dispositif de retenue (113 ; 213) lors d'un contact mécanique avec la position de libération prédéterminée, et mettent ainsi fin à la fixation de l'au moins un outil de pliage (109 ; 209).

7. Machine à plier selon la revendication 6, **caractérisée en ce qu'**un élément de contact (117 ; 217) respectif est conçu de telle sorte que, lorsqu'il atteint la position de libération prédéterminée, il appuie contre au moins une surface de contact (127 ; 227) du dispositif de retenue (113 ; 213) et déclenche ainsi un déplacement du dispositif de retenue (113 ; 213), ce qui met fin à la fixation de l'au moins un outil de pliage (109 ; 209).

8. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le dispositif de retenue (113 ; 213) est un dispositif de serrage qui est conçu de telle sorte qu'il exerce une force de retenue sous la forme d'une force de serrage sur l'au moins un outil de pliage (109 ; 209) pour fixer l'au moins un outil de pliage (109 ; 209).

9. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le dispositif de retenue (113 ; 213) comprend un ou plusieurs moyens élastiques (121 ; 221) qui sont précontraints dans le dispositif de retenue (113 ; 213) pour générer ainsi une force de retenue pour la fixation de l'au moins un outil de pliage (109 ; 209).

10. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le dispositif de retenue (113 ; 213) comprend un ou plusieurs dispositifs anti-perte (122 ; 222) pour retenir l'au moins un outil de pliage (109 ; 209) avec du jeu dans le dispositif de retenue (113 ; 213) lorsque le dispositif de retenue (113 ; 213) est ouvert, et/ou un ou plusieurs moyens de positionnement (123 ; 223) pour garantir que, lorsque la position de libération prédéterminée est atteinte, l'au moins un outil de pliage (109 ; 209) se déplace dans une position prédéterminée dans laquelle l'au moins un outil de pliage (109 ; 209) est retenu par le dispositif de retenue (113 ; 213).

11. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce qu'**un système de capteurs (108) est disposé dans la machine à plier (100 ; 200), lequel est configuré pour détecter l'approche de la barre plieuse (105 ; 205, 205') en direction de la position de libération prédéterminée en tant qu'événement de détection, dans laquelle la machine à plier (100 ; 200) est de préférence conçue de telle sorte que, lorsque l'événement de détection est détecté, un message est émis par le biais d'une interface utilisateur (111) de la machine à plier (100 ; 200).

12. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le moyen de libération (116 ; 216) peut être déplacé dans une position de stationnement sur la machine à plier dans laquelle le moyen de libération (116 ; 216) ne peut pas être actionné par le déplacement de la barre plieuse (105 ; 205, 205').

13. Machine à plier selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la machine à plier (100 ; 200) est une presse plieuse (100) pour plier librement une pièce entre une barre supérieure mobile (105) et une barre inférieure fixe (106), dans laquelle la barre plieuse (105 ; 205, 205') est la barre supérieure (105).

14. Machine à plier selon la revendication 13, **caractérisée en ce que** le dispositif de retenue (113 ; 213) est disposé sur la barre supérieure (105) pour retenir l'au moins un outil de pliage (109 ; 209) sur la barre supérieure (105), et le moyen de libération (116 ; 216) est disposé de manière à être adjacent à demeure à la barre supérieure (105), dans laquelle la position de libération prédéterminée est atteinte par le déplacement de la barre supérieure (105) dans le sens de travail (z) en s'éloignant de la barre inférieure (106).

15. Machine à plier selon l'une quelconque des revendications 1 à 12, **caractérisée en ce que** la machine à plier (100 ; 200) est une plieuse de panneaux (200) qui est conçue de telle sorte que la pièce est fixée pendant le pliage.

16. Machine à plier selon la revendication 15, **caractérisée en ce que** le dispositif de retenue (113 ; 213) est disposée sur la barre plieuse (105 ; 205, 205') pour retenir l'au moins un outil de pliage (109 ; 209) sur la barre plieuse (105 ; 205, 205') et la position de libération prédéterminée se situe à l'extérieur d'une zone de travail dans laquelle a lieu le pliage par la barre plieuse (105 ; 205, 205'), dans laquelle la barre plieuse (113 ; 213) est de préférence mobile dans le sens de la largeur (y) de la plieuse de panneaux (200) dans la position de libération prédéterminée.

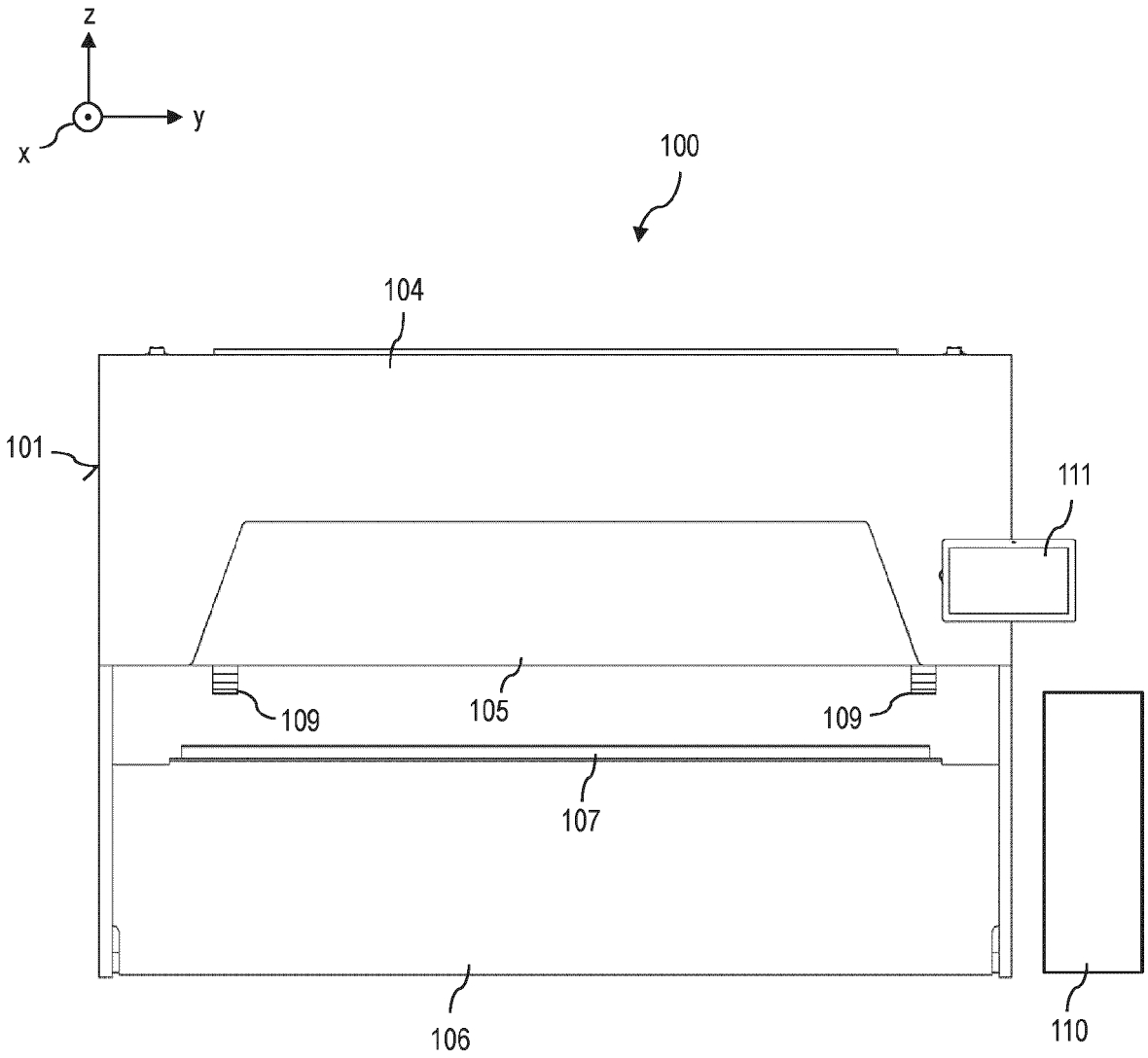


Fig. 1

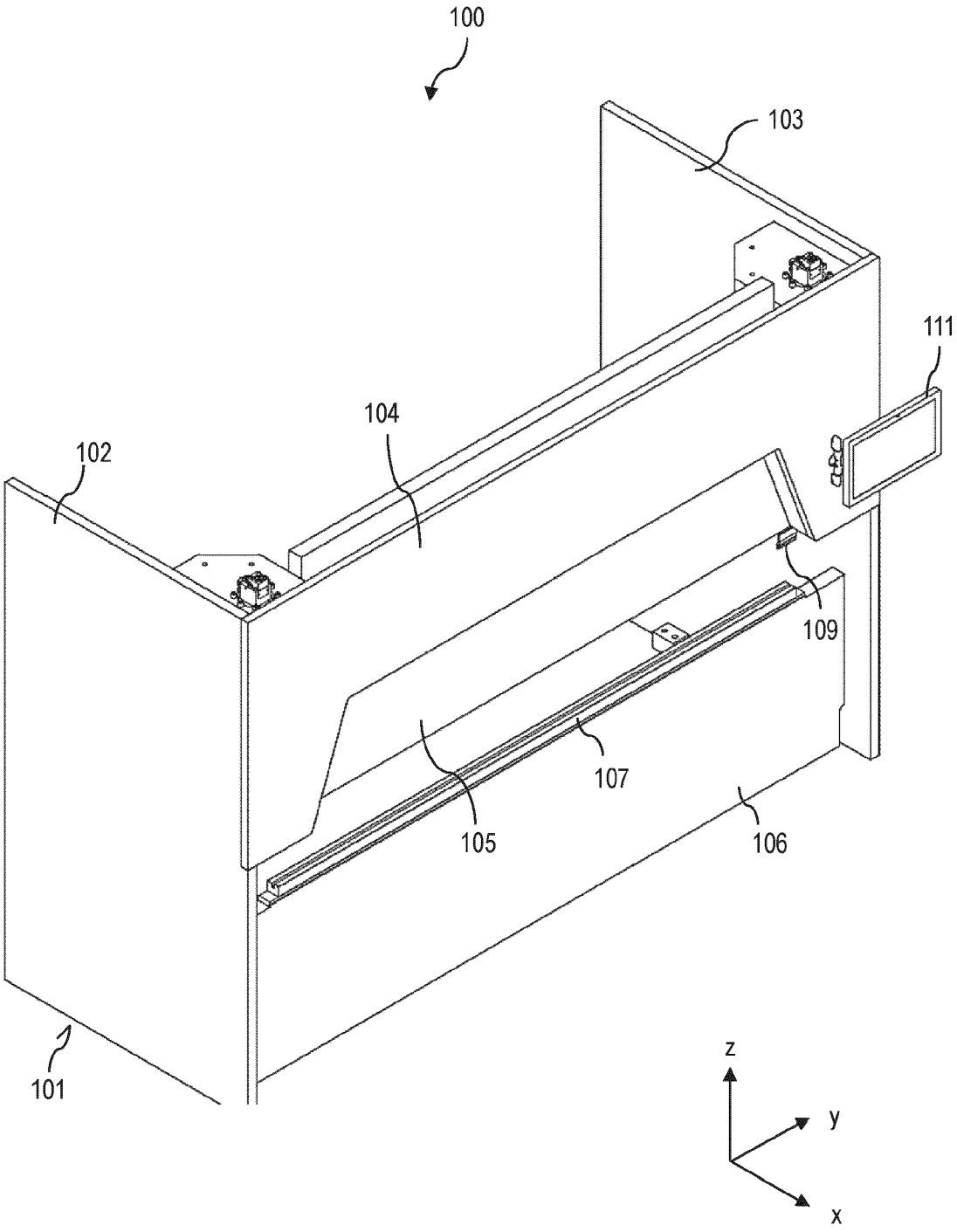


Fig. 2

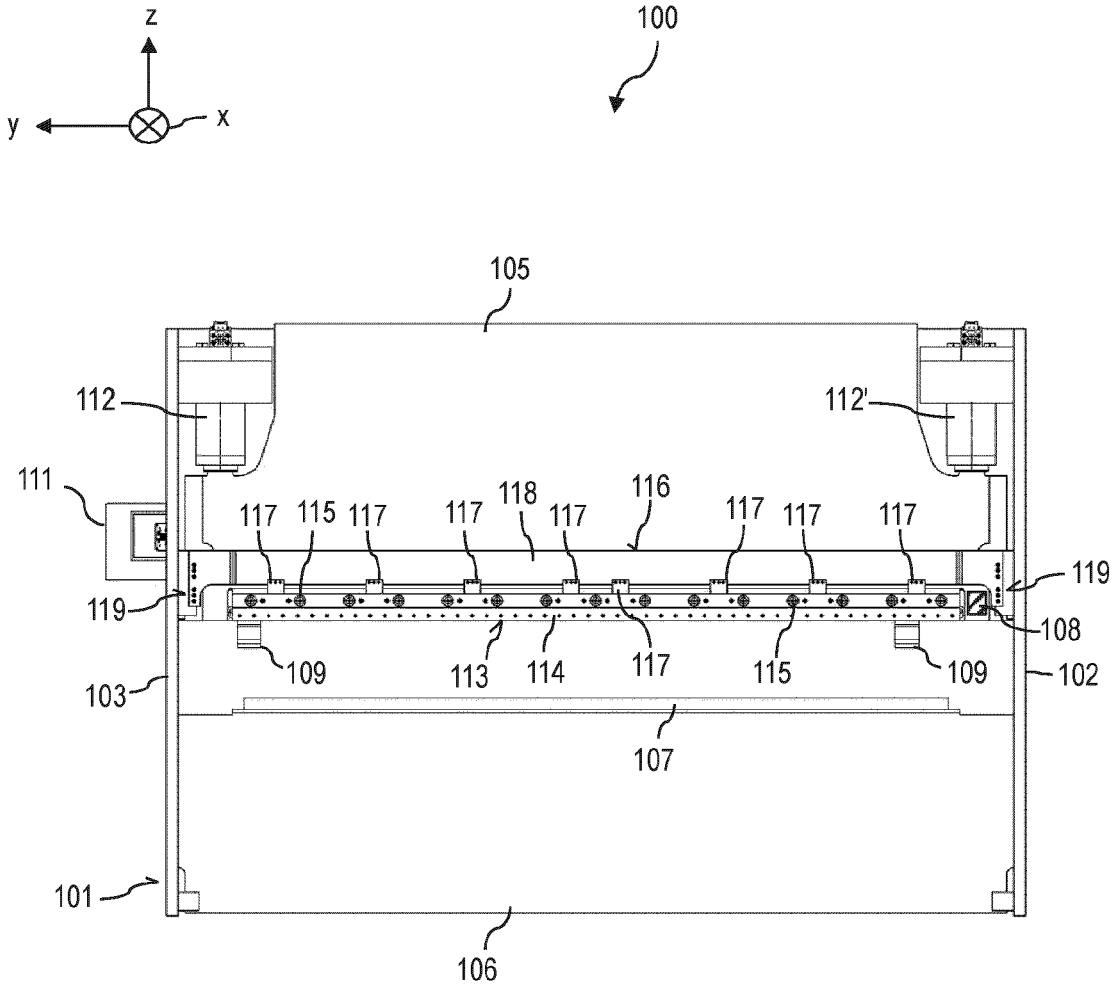

z
y
x
100
105
112
112'
111
117
115
118
116
119
108
109
113
114
103
102
107
101
106

Fig. 3

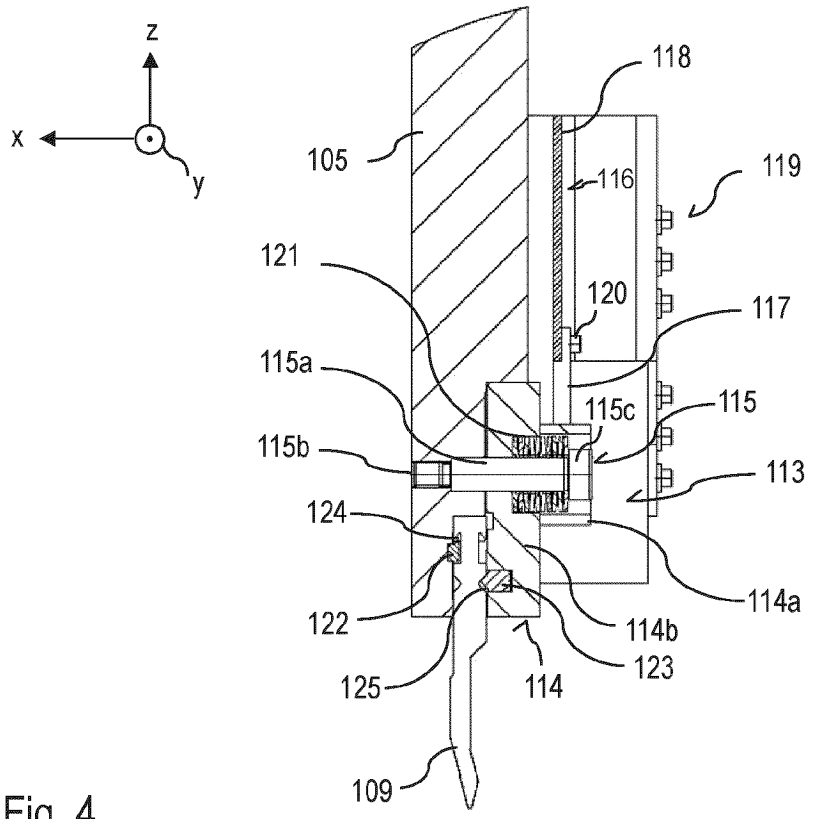

z
x
y
118
105
116
119
121
120
117
115a
115c
115
115b
113
124
114a
122
114b
123
125
114
109

Fig. 4

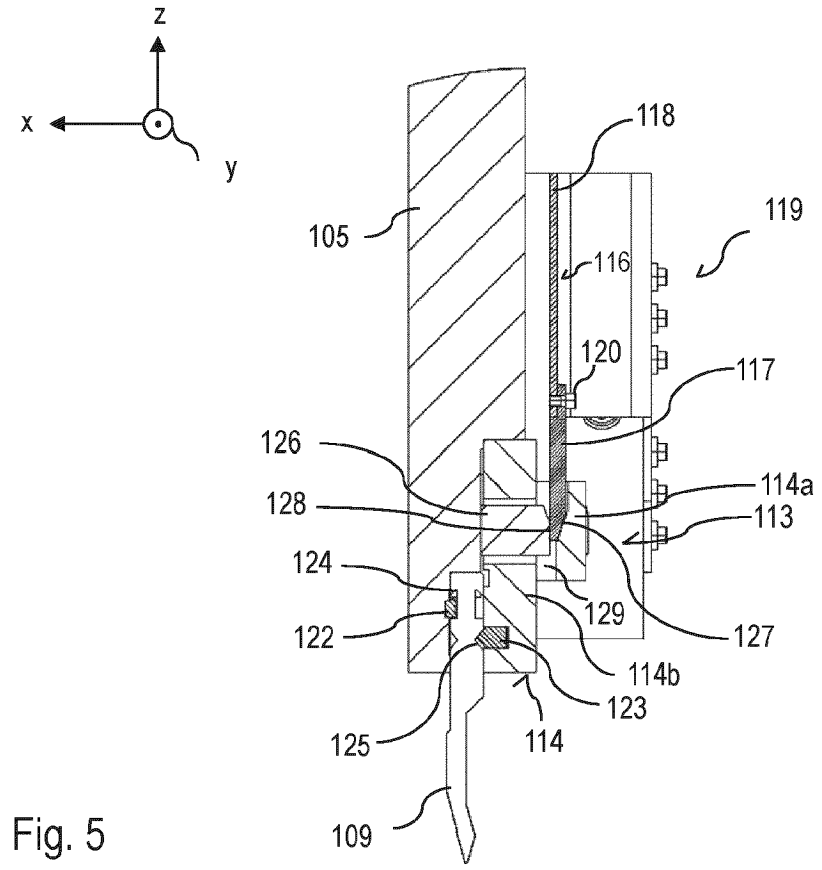
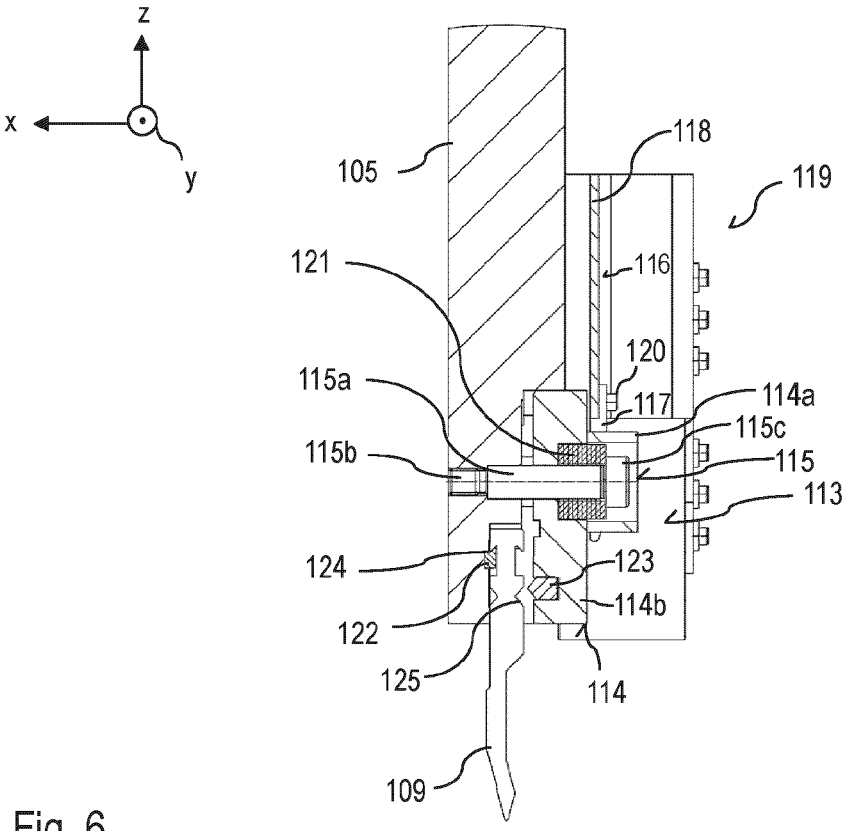

z
x
y
118
105
119
116
120
117
126
114a
128
113
124
129
127
122
114b
123
125
114
109

Fig. 5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x
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118
119
121
116
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115
113
124
123
114b
122
125
114
109

Fig. 6

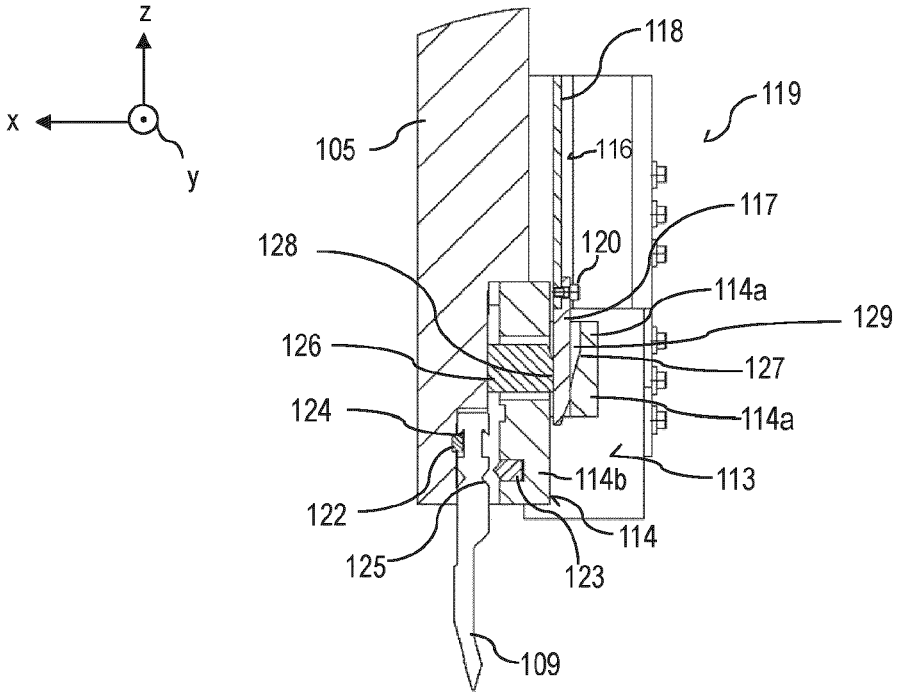

z
x
y
118
119
105
116
117
128
120
114a
129
126
127
124
114a
114b
113
122
114
125
123
109

Fig. 7

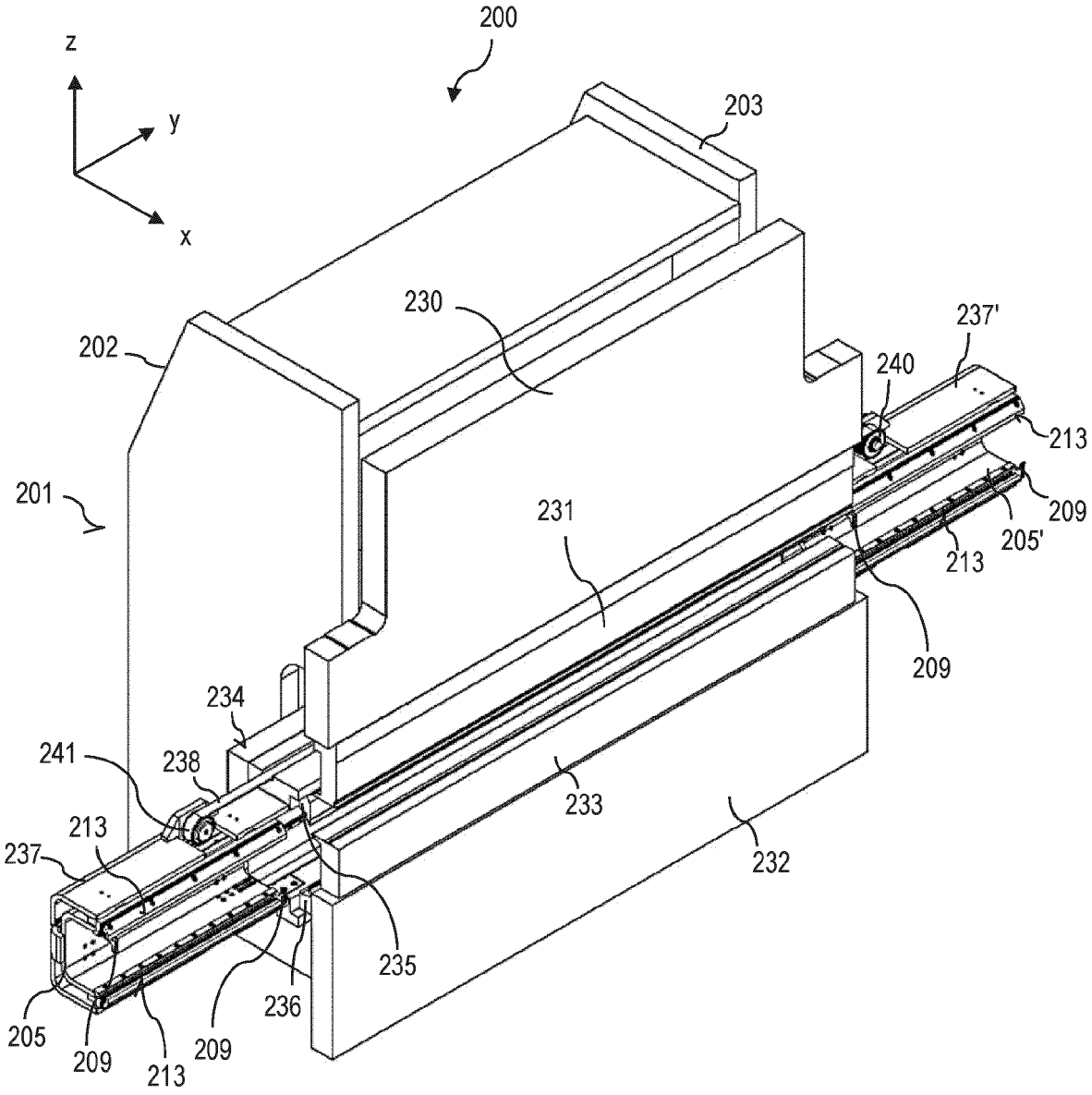

200
z
y
x
203
230
202
237'
240
213
201
209
231
205'
213
209
234
241
238
233
213
237
232
235
205
209
213
209
236

Fig. 8

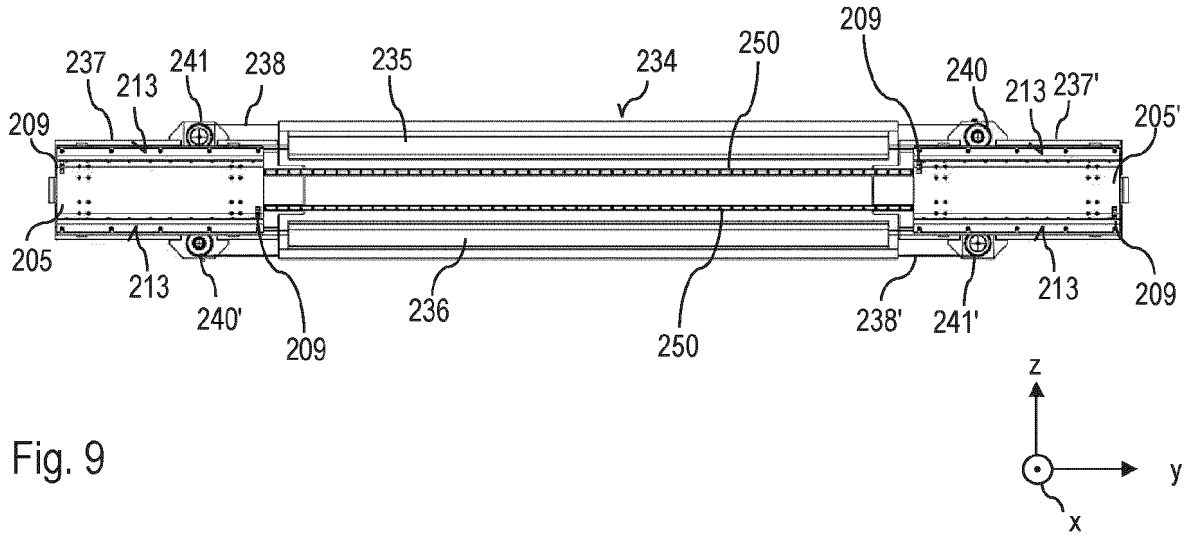
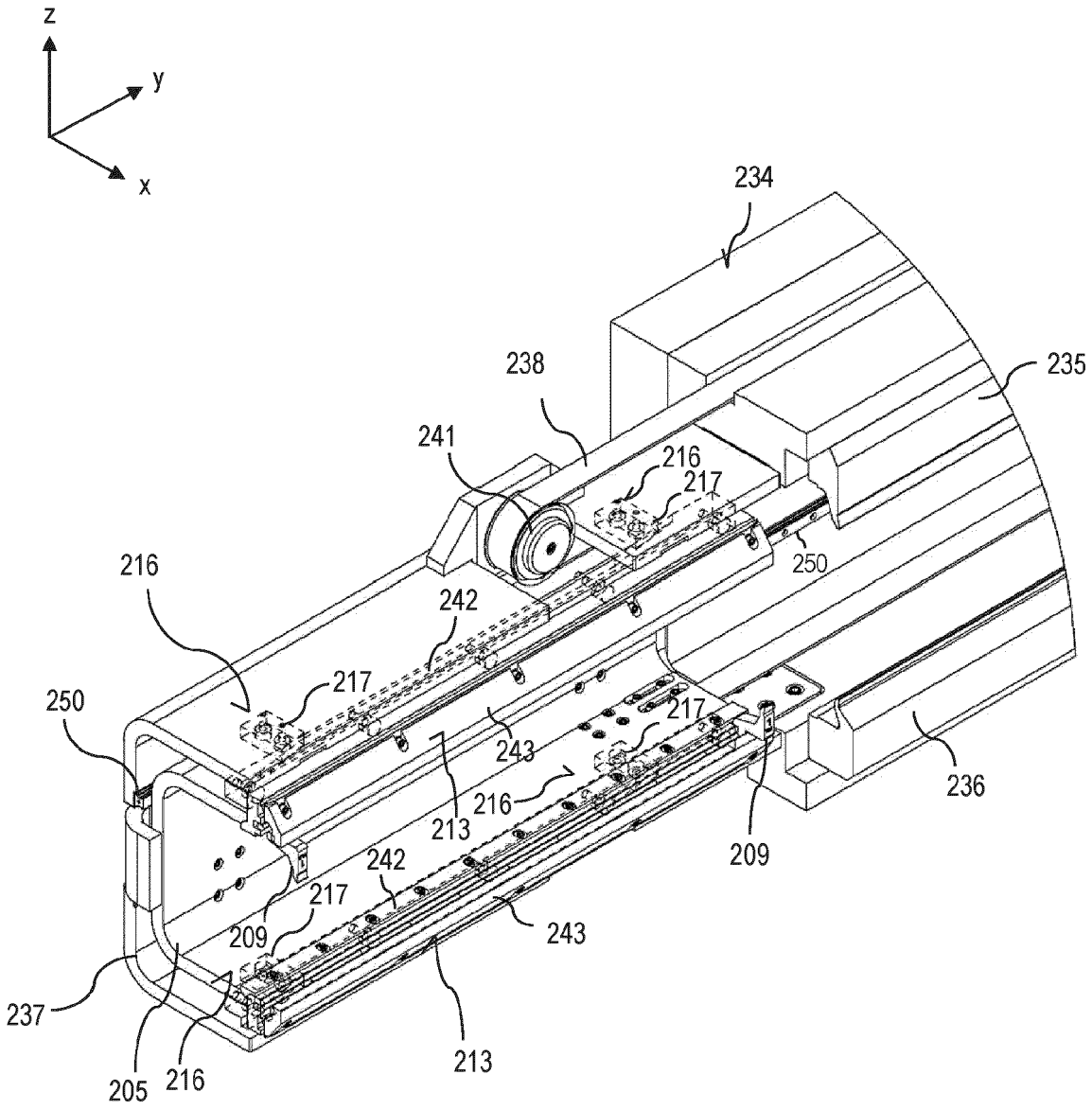

209
237
213
241
238
235
234
250
240
213
237'
205'
209
205
213
240'
209
236
250
238'
241'
213
209
z
y
x

Fig. 9


z
y
x
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238
235
241
216
217
250
216
242
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243
217
216
213
209
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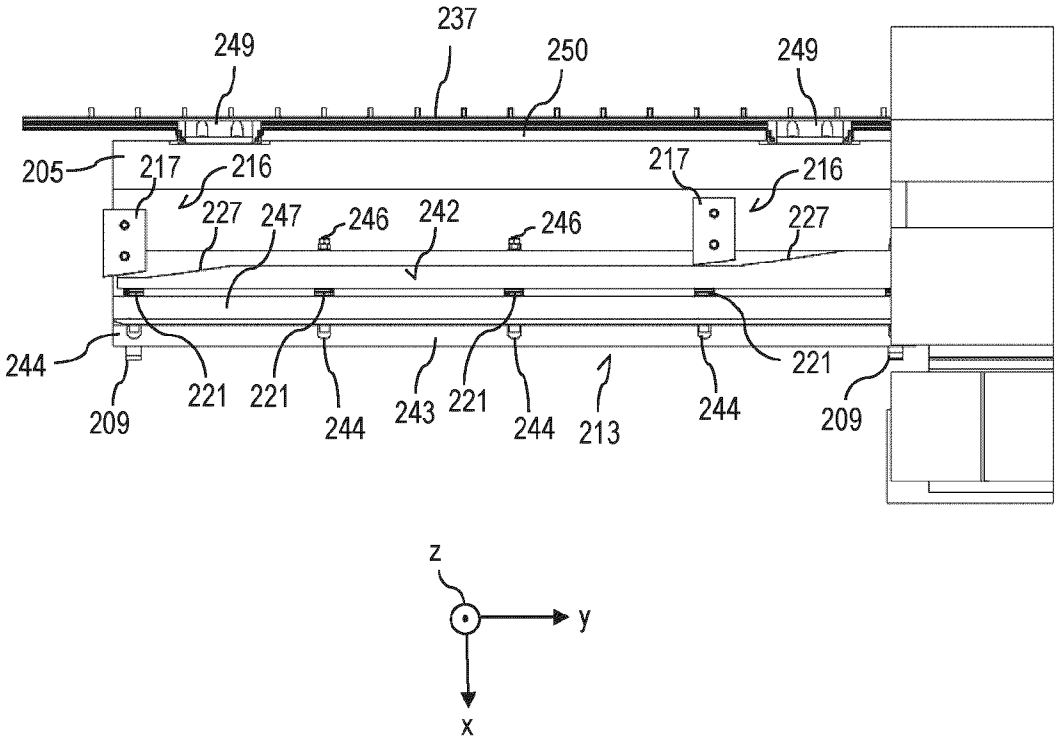
217
209
243
237
205
216
213
236

Fig. 10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205
217
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227
247
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242
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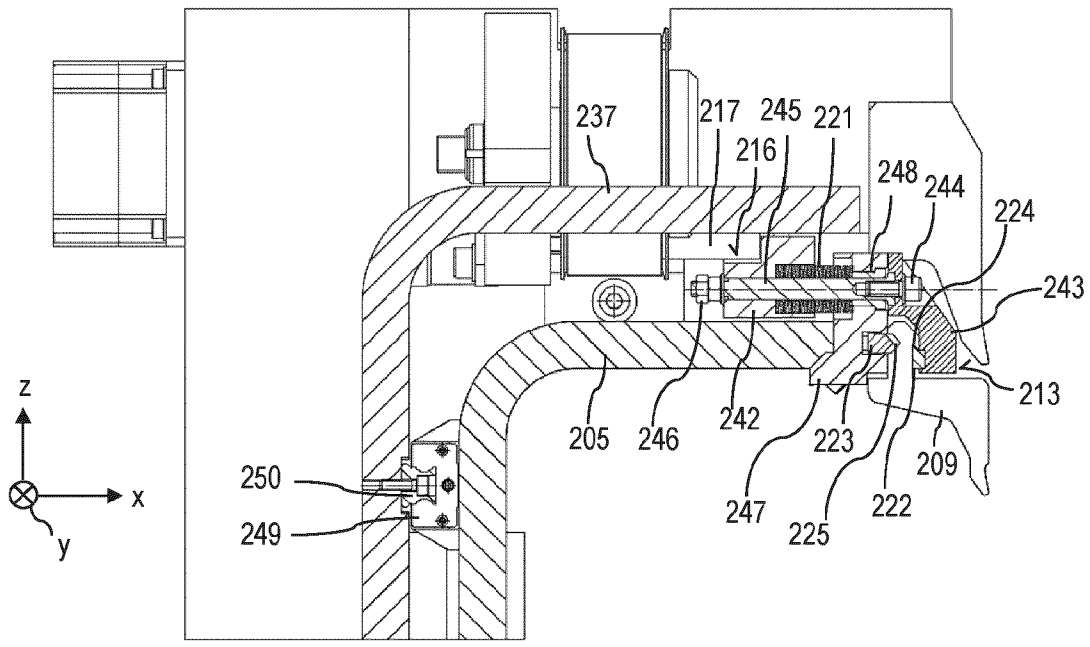
227
244
221
221
243
221
244
213
244
221
209
209
z
y
x

Fig. 11


237
217
245
221
216
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244
224
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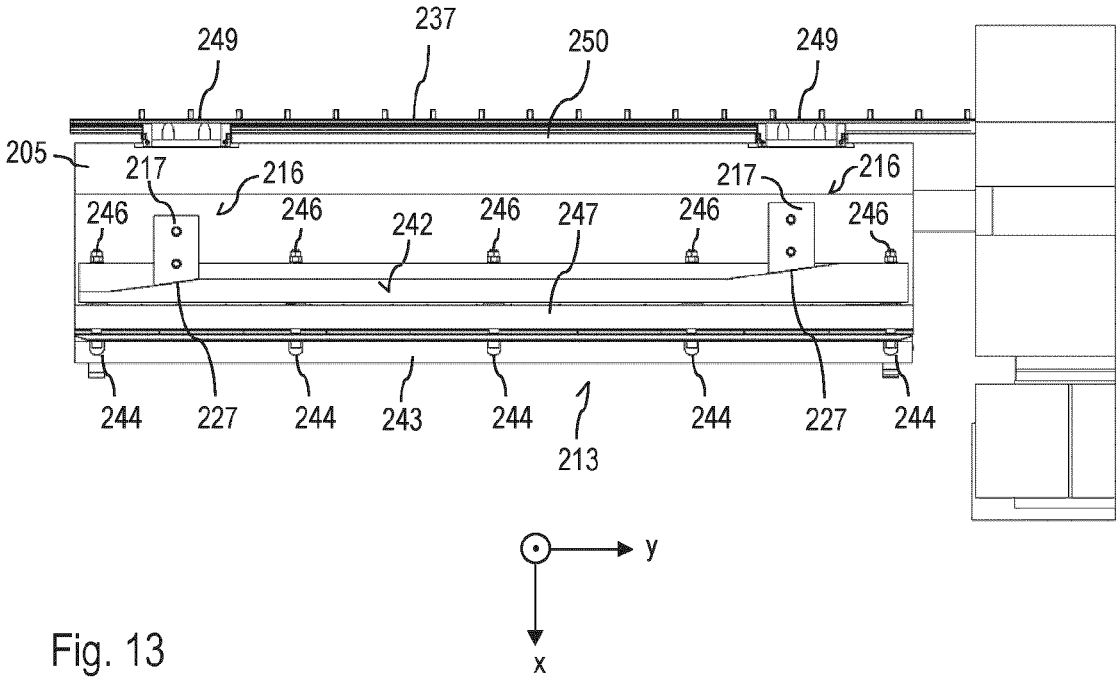
213
205
246
242
223
209
247
225
222
250
249
z
x
y

Fig. 12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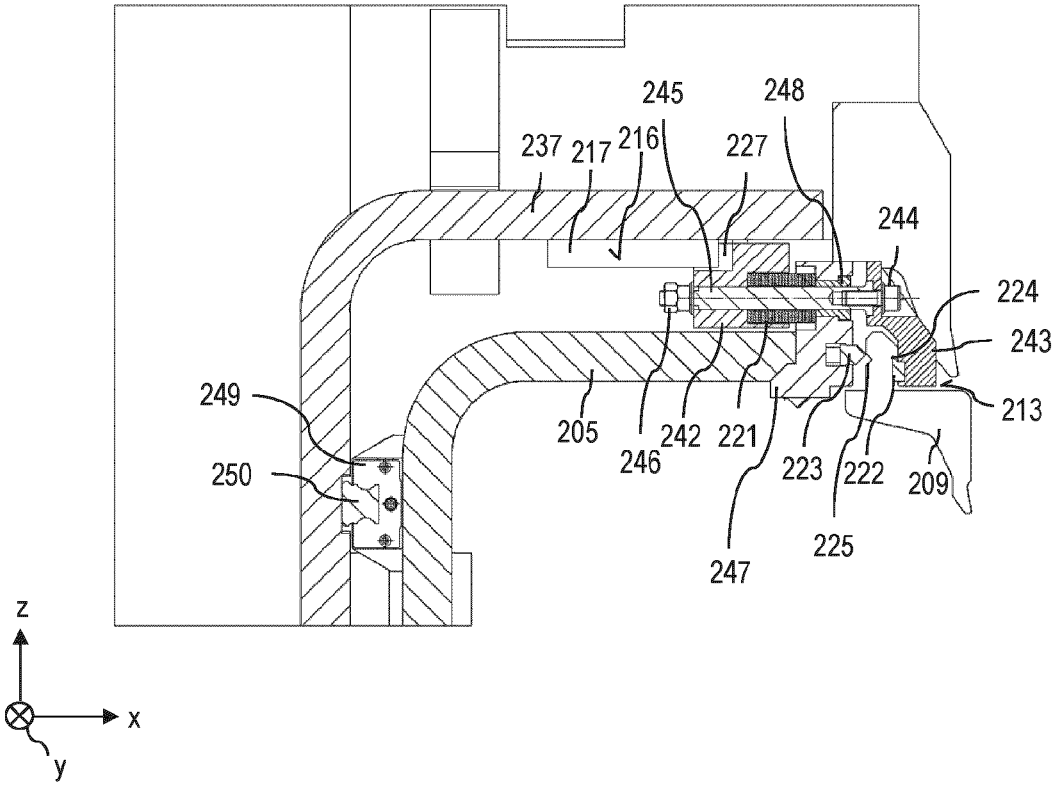
244
227
244
243
244
213
244
227
244
y
x

Fig. 13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237
217
216
227
244
224
243
249
213
205
242
221
246
223
222
209
250
225
247
z
x
y

Fig.14

REFERENCES CITED IN THE DESCRIPTION

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