



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **07.05.2008 Bulletin 2008/19**
(51) Int Cl.: **B21D 5/02 (2006.01) B21D 5/04 (2006.01)**
B21D 37/04 (2006.01)
(21) Application number: **07019369.3**
(22) Date of filing: **02.10.2007**

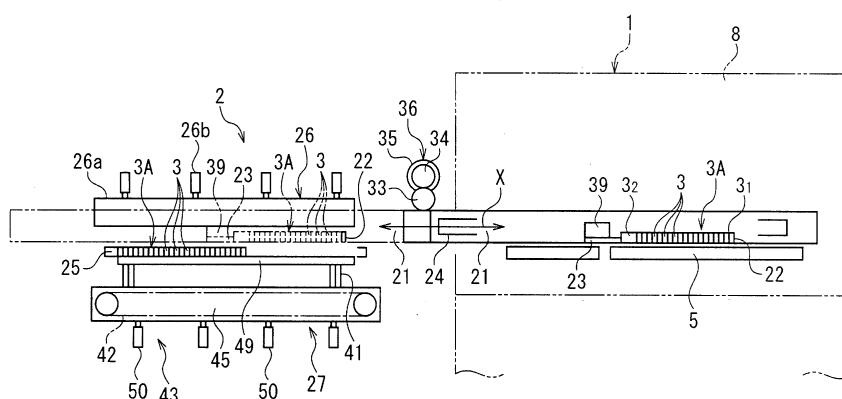
(84) Designated Contracting States: AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR Designated Extension States: AL BA HR MK RS (30) Priority: 02.11.2006 JP 2006298783 (71) Applicant: Murata Machinery, Ltd. Kyoto 601 (JP)	(72) Inventor: Ito, Shunitsu Hashizume Inuyama-shi Aichi (JP) (74) Representative: Liedl, Christine et al c/o Hansmann & Vogeser, Albert-Rosshaupter-Strasse 65 81369 München (DE)
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(54) **Bending machine with bending tool length adjusting mechanism**

(57) The present invention provides a bending machine with a bending tool length adjusting mechanism which enables the opposite ends of a bending tool group to be rounded even with a variation in the length of the bending tool group, allowing a bending piece to be processed so that an opening has a corner rounded portion in each corner portion. The bending machine carries out bending processing on a plate material using a bending tool group 3A composed of a plurality of bending tools 3 arranged in a line. The bending machine has a bending tool length adjusting mechanism 2 that adjusts the length of the bending tool group 3A. The bending tool length adjusting mechanism 2 has a traveling member 21 on which the bending tool group 3A is placed and which moves into and out of a machine main body 1. The

traveling member 21 has a pair of abutting members 22, 23 against which the opposite ends of the bending tool group 3A are abutted. An abutting member moving mechanism 24 is provided which moves the abutting member 23 in a bending tool arranging direction with respect to the traveling member 21. A bending tool storage mount 25 is provided on which surplus bending tools 3 not included in the bending tool group 3A are arranged along a traveling route for the traveling member 21. An unloading pusher mechanism 26 is provided which pushes out the bending tools 3 on the traveling member 21 onto the bending tool storage mount 25. A placing pusher mechanism 27 is provided which places any number of the bending tools 3 on the bending tool storage mount 25 onto the traveling member 21 (Fig.1.).

FIGURE 1



Description

Field of the Invention

[0001] The present invention relates to a bending machine with a bending tool length adjusting mechanism which carries out bending processing of a plate material, for example, bending processing of a bending piece provided around an inner window opening in a door panel.

Background of the Invention

[0002] As shown in Figure 16, in the prior art, a door panel 91 made of a sheet metal has a inner window opening 92 for natural illumination or the like and a bending piece 93 provided around the periphery of the opening 92 to allow a glass plate to be fitted into the opening. Bending processing of the bending piece 93 is carried out by wipe-bending processing in which the periphery of the opening 92 in the door panel 91 is wipe-bent. The vertical and horizontal size of the opening 92 varies depending on the type of the door panel 91, and a dedicated bending machine is thus normally used which changes a bending tool depending on the size and type of the opening 92. However, a large number of tool types need to be provided when the appropriate one of the bending tools is prepared for each vertical and horizontal size of the opening 92. This is uneconomical. Saving the number of tools prevents bending processing from being carried out on many types of openings 92 having different shapes.

[0003] To solve this problem, proposals have been made of bending machines which make it possible to adjust the length of a wipe-bending tool in accordance with the size of the inner window (for example, the Examined Japanese Patent Application Publication (Tokko-Hei) No. 5-38659 and the Japanese Patent No. 3201308). These bending machines use a bending tool group including a plurality of bending tools arranged in a line so as to adjust the length of the bending tool by selecting the number of bending tools used.

[0004] The conventional bending machines with the bending tool length adjusting mechanisms all adjust the length of the bending tools inside the bending machine main body. This limits an adjustment form. For example, in the door panel 91 in Figure 16, a bending piece 93 is separated into fragments corresponding to respective peripheral sides. Bending processing of the bending piece 93 can be achieved by any of the conventional bending machines with the bending tool length adjusting mechanisms.

[0005] However, as shown in Figure 15, the bending piece 93 may need to be continuous along the four sides of the opening. In this case, the corner portion between the adjacent sides of the opening 92 needs to be processed into a corner rounded portion 93a that allows the bending piece 93 to be continuously curved. The inventor envisaged a method for forming such a continuous bend-

ing piece 93 in which the corner portions of the opening 92 are subjected to bending processing and thus formed into the corner rounded portions 93a and in which the sides of the opening 92 are then subjected to bending processing to form a bending piece 93 that is continuous along the four sides of the opening as shown in Figure 15.

[0006] However, the conventional bending machines with the bending tool length adjusting mechanisms increase or reduce the number of bending tools from an end of the bending tool group. This makes the opposite ends of the bending tool group angular. That is, the bending tools of the bending tool group need to have a continuous shape. Thus, a portion of each bending tool which is adjacent to the next bending tool cannot be formed into a round shape. This makes the opposite ends of the bending tool group square. However, the bending piece 93 having the corner rounded portions 93a as shown in Figure 15 cannot be subjected bending processing using a bending tool group with square opposite ends as described above.

[0007] An object of the present invention is to provide a bending machine with a bending tool length adjusting mechanism which provides a certain degree of freedom for the form of length adjustment of bending tools.

[0008] Another object of the present invention is to enable the opposite ends of a bending tool group to be rounded even with a variation in the length of the bending tool group, allowing a bending piece to be processed so that an opening has a corner rounded portion in each corner portion.

[0009] Yet another object of the present invention is to allow any number of the bending tools to be smoothly placed on a traveling member that travels with the bending tool group placed thereon.

Summary of the Invention

[0010] The present invention provides a bending machine with a bending tool length adjusting mechanism, the bending machine having a bending tool group comprising a plurality of bending tools arranged in a line and a press driving mechanism that elevates and lowers a plate material relative to the bending tool group, the bending tool group carrying out bending processing on the plate material, the bending machine comprising a bending tool length adjusting mechanism that adjusts the length of the bending tool group in a bending tool arranging direction.

[0011] The bending tool length adjusting mechanism comprises a traveling member on which the bending tool group is placed and which moves into and out of a bending machine main body in the bending tool arranging direction, the bending machine main body comprising the press driving mechanism, a pair of abutting members which is provided on the traveling member and against which opposite ends of the bending tool group on the traveling member are abutted, an abutting member moving mechanism that moves one or both of the abutting

members in the bending tool arranging direction with respect to the traveling member, a bending tool storage mount which is provided outside the bending machine main body along a traveling route for the traveling member and on which surplus bending tools not included in the bending tool group are placed in juxtaposition along the traveling route, an unloading pusher mechanism that pushes out the bending tools on the traveling member onto the bending tool storage mount, and a placing pusher mechanism that places any number of the bending tools on the bending tool storage mount onto the traveling member.

[0012] In this configuration, the bending tool length adjusting mechanism allows the traveling member with the bending tool group placed thereon to move into and out of the bending machine main body, and the bending tool length adjusting mechanism thus selects, outside the bending machine main body, a bending tool to be loaded onto the traveling member from the bending tool group. In this case, the traveling member has the pair of abutting members provided thereon, and against which the opposite ends of the bending tool group are abutted for positioning and the abutting member moving mechanism provided thereon to move the abutting members. This enables the bending tool group placed on the traveling member and having one of various possible lengths to be fixed using the abutting members. This provides a certain degree of freedom for the form of length adjustment of the bending tools. For example, the number of bending tools located in the middle of the bending tool group can be changed with the bending tools at the opposite ends of the bending tool group remaining unchanged. Specifically, the number of bending tools located in the middle of the bending tool group can be changed by the following configuration.

[0013] For example, the bending tool group on the traveling member may have end-only bending tools positioned at opposite ends of the bending tool group. An end of an arrangement of the bending tool group at a tip surface of the end-only bending tool may constitute a curved surface portion exhibiting a curved line in a cross section in the bending tool arranging direction. The abutting member moving mechanism may be able to move the end-only bending tool located farther from the bending machine main body, to a position where the end-only bending tool lies away from an end of a maximum arranging length of the bending tools on the bending tool storage mount. Where the end-only bending tools are thus provided, the corners of the ends of the arrangement of the bending tool group can be rounded so as to have the curved surface portions. This enables the bending piece to be processed so that the opening has the corner rounded portion in each of the corner portions. Even with the end-only bending tools provided as described above, where the abutting member moving mechanism is able

maximum arranging length of the bending tools on the bending tool storage mount, the number of the bending tools in the middle of the bending tool group can be selected.

5 **[0014]** In the present invention, the placing pusher mechanism may comprise a plurality of push rods arranged in juxtaposition along bending tool arranging positions on the bending tool storage mount, and at a position opposite to the traveling route, an endless pivoting member located opposite the traveling route so that a pivoting route for the endless pivoting member extends along an arrangement of the push rods, a pivoting member moving forward and backward mechanism that moves the endless pivoting member forward and backward with respect to the push rods, and a plurality of selective pushing members which are provided in a part of the endless pivoting member in a length direction thereof and in juxtaposition in the length direction, the selective pushing members pushing the push rods as a result of movement of the endless pivoting member carried out by the pivoting member moving forward and backward mechanism. With this configuration, the endless pivoting member pivots to allow the adjustment of the length of the selective pushing member along the bending tool arranging position on the bending tool storage mount. This allows those of the bending tools on the bending tool storage mount the number of which corresponds to the adjusted length, to be placed on the traveling member. Thus, the length of the bending tool group on the traveling member can be smoothly adjusted.

30 **[0015]** The present invention provides the bending machine with the bending tool length adjusting mechanism, the bending machine having the bending tool group comprising the plurality of bending tools arranged in a line and the press driving mechanism that elevates and lowers the plate material relative to the bending tool group, the bending tool group carrying out bending processing on the plate material, the bending machine comprising the bending tool length adjusting mechanism that adjusts the length of the bending tool group in the bending tool arranging direction. The bending tool length adjusting mechanism comprises the traveling member on which the bending tool group is placed and which moves into and out of the bending machine main body in the bending tool arranging direction, the bending machine main body comprising the press driving mechanism, the pair of abutting members which is provided on the traveling member and against which opposite ends of the bending tool group on the traveling member are abutted, the abutting member moving mechanism that moves one or both of the abutting members in the bending tool arranging direction with respect to the traveling member, the bending tool storage mount which is provided outside the bending machine main body along the traveling route for the traveling member and on which the surplus bending tools not included in the bending tool group are placed in juxtaposition along the traveling route, the unloading pusher mechanism that pushes out the bending tools on the

traveling member onto the bending tool storage mount, and the placing pusher mechanism that places any number of the bending tools on the bending tool storage mount onto the traveling member. This provides a certain degree of freedom for the form of length adjustment of the bending tools.

[0016] Where the bending tool group on the traveling member has the end-only bending tools positioned at opposite ends of the bending tool group, and the end of the arrangement of the bending tool group at the tip surface of the end-only bending tool constitutes the curved surface portion exhibiting the curved line in a cross section in the bending tool arranging direction, and the abutting member moving mechanism is able to move the end-only bending tool located farther from the bending machine main body, to the position where the end-only bending tool lies away from the end of the maximum arranging length of the bending tools on the bending tool storage mount, the ends of the bending tool group can be rounded even with a variation in the length of the bending tool group. This enables the bending piece to be processed so that the opening has the corner rounded portion in each of the corner portions.

[0017] Where the placing pusher mechanism comprises the plurality of push rods arranged in juxtaposition along the bending tool arranging positions on the bending tool storage mount and at a position opposite to the traveling route, the endless pivoting member located opposite the traveling route so that the pivoting route for the endless pivoting member extends along the arrangement of the push rods, the pivoting member moving forward and backward mechanism that moves the endless pivoting member forward and backward with respect to the push rods, and the plurality of selective pushing members which are provided in the part of the endless pivoting member in the length direction thereof and in juxtaposition in the length direction, the selective pushing members pushing the push rods as a result of movement of the endless pivoting member carried out by the pivoting member moving forward and backward mechanism, any number of the bending tools can be smoothly placed on the traveling member traveling with the bending tool group placed thereon.

[0018] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0019]

Figure 1 is a schematic plan view of a bending machine with a bending tool length adjusting mechanism in accordance with an embodiment of the present invention.

Figure 2 is a schematic front view of the interior of

the bending machine main body as viewed from a front side.

Figure 3 is an enlarged exploded side view showing an upper tool, a lower tool, and a bending tool in the bending machine main body.

Figure 4 is a diagram illustrating a bending operation performed by the bending machine main body.

Figure 5 is a perspective view of a bending tool group.

Figure 6 is an exploded side view of the bending tool length adjusting mechanism.

Figure 7 is a front view showing the relationship between a traveling member and the bending tool group and an abutting member moving mechanism in the bending tool length adjusting mechanism.

Figure 8 is a plan view showing that the traveling member in the bending tool length adjusting mechanism has moved out of the bending machine main body.

Figure 9 is a plan view showing another operational state of the bending tool length adjusting mechanism.

Figure 10 is a plan view showing yet another operational state of the bending tool length adjusting mechanism.

Figure 11 is a plan view showing still another operational state of the bending tool length adjusting mechanism.

Figure 12 is a plan view showing further another operational state of the bending tool length adjusting mechanism.

Figure 13 is a plan view showing the operational states of an end-only bending tool changing mechanism.

Figure 14 is a perspective view of a door panel as an example of a bending processing target.

Figure 15 is a perspective view showing that bending processing has been completed on the door panel.

Figure 16 is a perspective view of a door panel processed by a conventional device.

Detailed Description of the Preferred Embodiments

[0020] An embodiment of the present invention will be described with reference to the drawings. As shown in Figure 1 and Figure 2, a bending machine with a bending tool length adjusting mechanism comprises a bending machine main body 1 and the bending tool length adjusting mechanism 2. The bending machine main body 1 has a bending tool group 3A composed of a plurality of bending tools 3 arranged in a line, and a press driving mechanism 6 (Figure 2) that elevates and lowers a plate material W with respect to the bending tool group 3A. The bending machine main body 1 thus uses the bending tool group 3A to carry out wipe-bending processing on the plate material W. The press driving mechanism 6 comprises a ram 7 installed on a press frame 8 via a guide 9 so as to be able to elevate and lower freely and a driving

mechanism (not shown in the drawings) that elevates and lowers the ram 7.

[0021] As shown in an enlarged view in Figure 3, the bending machine main body 1 has, as tools, not only the bending tools 3 but also an upper tool 4 and a lower tool 5 that sandwich the plate material W between the upper tool 4 and the lower tool 5. The upper tool 4 is mounted in an upper tool beam 10 mounted at a lower end of the ram 7. A plurality of the upper tools 4 are arranged in a line to constitute an upper tool group 4A, and selection of the number of upper tools 4 enables the length of the upper tools 4 to be adjusted. The lower tool 5 is installed on a lower tool block 11, and the bending tool group 3A is positioned along a rear surface of the lower tool 5. The upper tool beam 10 has a backup member 12, and the lower tool block 11 has a step portion 13 with which a lower end of the backup member 12 is engaged.

[0022] The lower tool block 11 has a built-in cushion pad 14 that corrects bending strain in the direction of a fold line, with the lower tool 5 installed on the cushion pad 14. The cushion pad 14 is fitted in a fluid pressure chamber 15 provided in the lower tool block 11. The cushion pad 14 can be elevated and lowered by an operating fluid such as oil or air which is fed into and discharged from the fluid pressure chamber 15 through a channel 16.

[0023] For bending processing, the bending machine main body 1 elevates and lowers the ram 7 to allow the upper tools 4 to press the plate material W located on the lower tool 5 as shown in Figure 3, against the lower tool 5 as shown in Figure 4A. The plate material W sandwiched between the upper tools 4 and the lower tool 5 is further lowered against the cushion pad 14 by the ram 7 as shown in Figure 4B. Thus, the plate material W is lowered with respect to the lower tool group 3A to fold an edge of the plate material W which projects from the upper tools 4, between the bending tool group 3A and the upper tools 4, thus forming a bending piece Wa. That is, wipe-bending is carried out.

[0024] As shown in Figure 5, the plurality of bending tools 3 are arranged in a line to constitute the bending tool group 3A. The bending tools 3 located at the opposite ends of the bending tool group 3A are end-only bending tools 3_1 , 3_2 . To change the length of the bending tool group 3A, the number of the bending tools 3 in the middle of the bending tool group 3A is changed, with the end-only bending tools 3_1 , 3_2 arranged at the opposite ends of the group 3A. The bending tool group 3A has the same sectional shape all over the length thereof. Each of the bending tools 3 in the middle of the bending tool group 3A has a shape obtained by cutting the bending tool group 3A at every given width at a plane perpendicular to a length direction. However, for each of the end-only bending tools 3_1 , 3_2 , located at the opposite ends of the bending tool group 3A, the end of the arrangement of the bending tool group 3A at a tip surface of the end-only bending tools 3_1 , 3_2 constitutes a curved surface portion 3a exhibiting a curved line in a cross section in a bending tool arranging direction. The curved surface por-

tion 3a is, for example, a spherically curved surface.

[0025] One of the end-only bending tools 3_1 , 3_2 at the opposite ends of the bending tool group 3A (the end-only bending tool located at that end of the bending tool group 3A which first moves out of the bending machine main body 1) is wider than the middle bending tools 3 and has one of a plurality of (in this case, two) replaceable end-only bending tools 3_{21} , 3_{22} (Figure 8) having different tool widths B. The difference between the size of one of the plurality of end-only bending tools 3_{21} , 3_{22} and the tool width of the middle bending tools 3 or a multiple of the tool width is different from that between the size of the other end-only bending tool and the tool width or a multiple thereof. The use of the plural types of end-only bending tools 3_{21} , 3_{22} enables the bending tool group 3A to be changed more precisely than selection of the number of the middle bending tools 3. Further, the end-only bending tool 3_2 (3_{21} , 3_{22}) at the one end of the bending tool group 3A has an engaged portion 3b that allows the bending tool group 3A to move in the bending tool arranging direction. An engaging portion 23b (Figure 7) that is engaged with the engaged portion 3b has a shape that enables engagement with and disengagement from the end-only bending tool 3_2 in a thickness direction thereof (the direction orthogonal to the bending tool arranging direction); the engaging portion 23b is shaped like, for example, a key or a groove.

[0026] In Figure 1, the bending tool length adjusting mechanism 2 is a mechanism that adjusts the length of the bending tool group 3A in the bending tool arranging direction. The bending tool length adjusting mechanism 2 comprises a traveling member 21 on which the bending tool group 3A is placed and which moves into and out of the bending machine main body 1 in the bending tool arranging direction, a pair of abutting members 22, 23 which is provided on the traveling member 21 and against which the opposite ends of the bending tool group 3A on the traveling member 21 are abutted, and an abutting member moving mechanism 24 that moves the abutting member 23 located farther from the bending machine main body 1, in the bending tool arranging direction with respect to the traveling member 21. Furthermore, the bending tool length adjusting mechanism 2 has a bending tool storage mount 25 which is provided outside the bending tool main body 1 along a traveling route for the traveling member 21 and on which surplus bending tools 3 not included in the bending tool group 3A are placed in juxtaposition along the traveling route, an unloading pusher mechanism 26 that pushes out the bending tools 3 on the traveling member 21 onto the bending tool storage mount 25, and a placing pusher mechanism 27 that places any number of the bending tools 3 on the bending tool storage mount 25 onto the traveling member 21.

[0027] The traveling member 21 is a laterally extending elongate member and is installed on a fixed base 28 via a guide mechanism 31 composed of a guide rail 29 and a direct-acting rolling bearing 30, so as to be able to move forward and backward, as shown in Figure 3. The guide

rail 29 is provided so that the traveling member 21 can travel from a position inside the bending machine main body 1 to a position outside and on a side of the bending machine main body 1. The traveling member 21 has a rack 32 provided on a rear surface thereof. As shown in Figure 1 and Figure 8, the traveling member 21 is moved forward and backward by a pinion 33 which is provided on a side of the bending machine main body 1 so as to mesh with the rack 32 and a traveling member moving forward and backward driving mechanism 36 composed of a servo motor 35 to drive the pinion 33 via a gear 34. The traveling member 21 is moved forward and backward by the servo motor 35 as described above and can thus be stopped at any position. While the bending tool group 3A placed on a top surface of the traveling member 21 is located at any lateral position in the bending machine main body 1, the bending machine main body 1 is able to carry out bending processing on the plate material W. The servo motor 35 is controlled by a traveling member position control device 59 (Figure 8) provided as a part of the function of a numerical control device that controls the bending machine.

[0028] As shown in Figure 7, the abutting member moving mechanism 24 is composed of a rod-less cylinder 38 provided on the traveling member 21 along the length direction, and a moving forward and backward member 39 moved in the length direction of the traveling member 21 by the rod-less cylinder 38. A movable one of the pair of abutting members 22, 23 is fixed to the moving forward and backward member 39. The movable-side abutting member 23 has the engaging portion 23b that releasably engages with the engaged portion 3b of the end-only bending tool 3₂.

[0029] As shown in Figure 6, the bending tool storage mount 25 has a bending tool placing surface 25a formed at the same level as that of a bending tool placing surface 21a of the traveling member 21 and in proximity to the bending tool placing surface 21a. Accordingly, the bending tools 3 can be transferred between the bending tool placing surfaces 21a, 25a by being slid on the bending tool placing surfaces 21a, 25a. The bending tool storage mount 25 has a regulating plate 25b projecting from a top surface thereof. The plurality of bending tools 3 are placed on the bending tool placing surface 25a in contact with the regulating plate 25b. The traveling member 21 has a rear surface abutting portion 40 that regulates the rear surface position of the bending tools 3.

[0030] The unloading pusher mechanism 26 is composed of a plate-like pusher 26a that moves forward and backward freely to push out the bending tools 3 on the traveling member 21 onto the bending tool storage mount 25, and a pusher moving forward and backward driving source 26b such as a plurality of hydraulic cylinders which moves the pusher 26a forward and backward. The pusher 26a has a length covering the entire length of the bending tool storage mount 25, and the pusher 26a is supported on the fixed base 28 by a guide member (not shown in the drawings) so as to move forward and back-

ward freely.

[0031] The placing pusher mechanism 27 has a plurality of push rods 41 provided along bending tool arranging positions on the bending tool storage mount 25 at a position opposite to the traveling route for the traveling member 21, an endless pivoting member 42 located opposite side the traveling route so that a pivoting route for the endless pivoting member 42 extends along the arrangement of the push rods 41, and a pivoting member moving forward and backward mechanism 43 that moves the endless pivoting member 42 forward and backward with respect to the push rods 41.

[0032] The push rods 41 are fitted into respective guide holes 25bb formed in the regulating plate 25b on the bending tool storage mount 25 so as to move forward and backward freely, and a spring member 44 such as a coil spring is provided around the outer periphery of each push rod 41 to urge the push rod 41 to move backward with respect to the bending tool 3.

[0033] As shown in Figure 8, the endless pivoting member 42 is composed of a chain installed around sprockets 46, 47 provided at the opposite ends of a moving forward and backward mount 45. The endless pivoting member 42 has selective pushing members 48 mounted to respective links (not shown in the drawings) of the chain constituting the endless pivoting member 42 to selectively push the plurality of push rods 41. The selective pushing members 48 are consecutively provided within a part of the range of the endless pivoting member 42 in a length direction thereof. The moving forward and backward mount 45 has a rear surface supporting member 49 which is provided over the entire length of the arranging range of the push rods 41 and against which rear surfaces of those of the selective pushing members 48 which are positioned closer to the arranging side of the push rods 41.

[0034] The pivoting member moving forward and backward mechanism 43 is composed of the moving forward and backward mount 45 with the endless pivoting member 42 installed thereon and a moving forward and backward driving source 50 such as a plurality of hydraulic cylinders which moves the moving forward and backward mount 45 forward and backward. The moving forward and backward mount 45 is installed on the fixed base 28 via a guide member (not shown in the drawings).

[0035] As shown in Figure 8 and Figure 11, an end of the bending tool storage mount 25 which is closer to the bending machine main body 1 side has a regulating pushing mechanism 51 that pushes the arrangement of the bending tools 3 arranged on the top surface of the bending tool storage mount 25, from one end of the arrangement. The regulating pushing mechanism 51 is composed of a hydraulic cylinder or the like.

[0036] As shown in Figure 8, an end-only bending tool changing mechanism 53 is provided opposite and along the bending machine main body 1 across the bending tool storage mount 25. As shown in Figure 13, the end-only bending tool changing mechanism 53 has a

movable storage mount 54 which is installed on a changing mechanism base 57 so as to be able to move forward and backward in a traveling member traveling direction X and on which the two movable-side end-only bending tools 3_{21} , 3_{22} can be placed. The end-only bending tool changing mechanism 53 also has an end tool pusher mechanism 55 and a movable storage mount moving forward and backward mechanism 56. The movable storage mount 54 has a top surface positioned at the same level as that of the bending tool placing surface 21a of the traveling member 21. The end tool pusher mechanism 55 is a mechanism that pushes one of the end-only bending tools 3_1 , 3_2 on the movable storage mount 54 onto the bending tool placing surface 21a of the traveling member 21 at a predetermined position. The end tool pusher mechanism 55 is composed of a hydraulic cylinder, an air cylinder, or the like. The movable storage mount moving forward and backward mechanism 56 is a mechanism that moves the movable storage mount 54 in the traveling member traveling direction X. The movable storage mount moving forward and backward mechanism 56 is composed of a hydraulic cylinder, an air cylinder, or the like.

[0037] A description will be given of a bending tool length adjusting operation performed by the above configuration. To change the length of the bending tool group 3A on the traveling member 21 located inside the bending machine main body 1 as shown in Figure 1, first, the traveling member 21 is allowed to travel out of the bending machine main body 1 to a position where the traveling member 21 lies next to the bending tool storage mount 25 as shown in Figure 8. At this time, the traveling member 21 is stopped at a position where a predetermined gap (d) (for example, several millimeters) is created between the position of the leading one of the bending tools 3 in the middle of the bending tool group 3A, that is, the bending tool 3 adjacent to the end-only bending tool 3_2 , and the position of one of the bending tools 3 arranged on the bending tool storage mount 25 which is closest to the bending machine main body 1. This stop position is controlled by the traveling member position control means 59. Always fixing the stop position of the traveling member 21 allows the traveling member 21 to be stopped at the position involving the predetermined gap (d). That is, even with a change in the length of the bending tool group 3A, the gap (d) remains fixed because the only difference is whether the bending tools 3 are placed on the traveling member 21 to constitute the bending tool group 3A or arranged on the bending tool storage mount 25.

[0038] After the traveling member 21 is stopped, the rod-less cylinder 38 of the abutting member moving mechanism 24 cooperates with the moving forward and backward member 39 in moving the movable-side abutting member 23 to a position where the end-only bending tool 3_2 lies away from the bending tool storage mount 25 as shown in Figure 9. This stop position of the moving forward and backward member 39 is a position where

the end-only bending tool 3_2 lines next to the movable storage mount 54 of the end-only bending tool changing mechanism 53 and to the vicinity of the pusher 26a of the unloading pusher mechanism 26.

[0039] Subsequently, the pusher 26a of the unloading pusher mechanism 26 moves forward to place all the bending tools 3 on the traveling member 21 except the end-only bending tools 3_1 , 3_2 onto the bending tool storage mount 25 (Figure 10). At this time, the gap (d) avoids the possible interference between the bending tools 3 unloaded from the traveling member 21 and the bending tools 3 on the bending tool storage mount 25. An end of the pusher 26a which is closer to the bending machine main body 1 is located at a position such that the end does not interfere with the abutting member 22. Thus, after the bending tools 3 on the traveling member 21 are transferred onto the bending tool storage mount 25, the gap (d) remains. However, as shown in Figure 11, the regulating pushing mechanism 51, composed of a cylinder device, pushes the arrangement of the bending tools 3 on the bending tool storage mount 25 from one end of the arrangement to eliminate the gap (d).

[0040] During the above series of operations, the placing pusher mechanism 27 pivots the endless pivoting member 42 so that the length of the selective pushing members 48 along the traveling member traveling route corresponds to the arranging width of the bending tools 3 required for the length of the next bending tool group 3A.

[0041] In this state, as shown in Figure 12, the endless pivoting member 42 as well as the moving forward and backward mount 45 are moved toward the traveling member 21 side by the moving forward and backward driving source 50 to allow the selective pushing members 48 to push those of the plurality of push rods 41 arranged in juxtaposition the positions of which correspond to the positions of the selective pushing members 48. A required number of the bending tools 3 arranged on the bending tool storage mount 25 are placed on the traveling member 21. Subsequently, the rod-less cylinder 38 of the abutting member moving mechanism 24 cooperates with the moving forward and backward member 39 in moving the movable-side abutting member 23 toward the bending machine main body 1 to press the movable-side end-only bending tool 3_2 against the arrangement of the bending tools 3 placed on the traveling member 21. This allows the bending tools 3 to be sandwiched between the opposite abutting members 22, 23 and fixed on the traveling member 21. This state is shown in Figure 12. After changing the length of the bending tool group 3A is thus completed, the traveling member 21 is allowed to move into the bending machine main body 1 and used for bending processing.

[0042] Figure 13 shows an operation of changing the two movable-side end-only bending tools 3_{21} , 3_{22} . Figure 13A shows that the traveling member 21 is moved out of the bending machine main body 1 and that the end-only bending tool 3_2 is moved together with the movable-side abutting member 23 as described above with reference

to Figure 8 and Figure 9. Subsequently, as shown in Figure 10, the pusher 26a of the unloading pusher mechanism 26 moves forward to place the bending tools 3 onto the bending tool storage mount 25. Then, the end-only bending tool 3₂₁ on the traveling member 21 is placed onto the movable storage mount 54 by the pusher 26a (Figure 13B).

[0043] To change the two end-only bending tools 3₂₁, 3₂₂ after the pusher 26a has returned (Figure 13C), the movable storage mount 54 is moved by the movable storage mount moving forward and backward mechanism 56 so that the end-only bending tool 3₂₂, which is to be next placed onto the movable storage mount 54, moves to the position corresponding to the end tool pusher mechanism 55 (Figure 13D). Subsequently, the end-only bending tool 3₂₂ on the movable storage mount 54 is moved onto the traveling member 21 by the end tool pusher mechanism 55 (Figure 13E).

[0044] The engaged portion 3b of each of the end-only bending tools 3₂₁, 3₂₂ and the engaging portion 23b of the movable-side abutting member 23 can be freely engaged with and disengaged from each other in a direction orthogonal to the traveling member traveling direction. Consequently, the pusher 26a and the end tool pusher mechanism 55 perform an operation of pushing the end-only bending tools 3₂₁, 3₂₂ for engagement or disengagement.

[0045] When the abutting member 23 is moved to end of the bending tool group 3A already transferred onto the traveling member 21 as shown in Figure 12, the end-only bending tool 3₂₂ changed as shown in Figure 13E is moved to change the movable-side end-only bending tool 3₂ of the bending tool group is changed to one of a different tool width.

[0046] Where the end-only bending tools 3₂₁, 3₂₂ are not changed, the operation of moving the movable storage mount 54 as shown in Figure 13D is omitted. This allows the end-only bending tool 3₂₁, (3₂₂) placed on the movable storage mount 54 to be used again for the bending tool group 3A.

[0047] The bending machine with the bending tool length adjusting mechanism configured as described above thus provides a certain degree of freedom for the form of length adjustment of the bending tools 3. In particular, the bending tool group 3A has the end-only bending tools 3₁, 3₂, positioned at the opposite ends thereof. The end of the arrangement of the bending tool group at the tip surface of each of the end-only bending tools 3₁, 3₂ constitutes the curved surface portion 3a exhibiting a curved line in a cross section in the bending tool arranging direction. Consequently, the opposite ends of the bending tool group 3A can be rounded even with a variation in the length of the bending tool group 3A. This enables the bending piece 93 to be processed so that the opening 92 has the corner rounded portion 93a in each of the corner portions as shown in Figure 15. In this case, the abutting member moving mechanism 24 is able to move the end-only bending tool 32 located farther from the

bending machine main body 1, to the position where the end-only bending tool lies away from the end of the maximum arranging length of the bending tools 3 on the bending tool storage mount 25. This allows the middle bending tools 3 to be smoothly changed without posing any problem such as interference, while using the end-only bending tool 3₂.

[0048] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the invention.

Claims

1. A bending machine with a bending tool length adjusting mechanism, the bending machine having a bending tool group comprising a plurality of bending tools arranged in a line, and a press driving mechanism that elevates and lowers a plate material relative to the bending tool group, said bending tool group carrying out bending processing on said plate material, the bending machine being **characterized by** comprising a bending tool length adjusting mechanism that adjusts the length of said bending tool group in a bending tool arranging direction, the bending tool length adjusting mechanism comprising a traveling member on which said bending tool group is placed and which moves into and out of a bending machine main body in said bending tool arranging direction, the bending machine main body comprising said press driving mechanism, a pair of abutting members which is provided on the traveling member and against which opposite ends of the bending tool group on the traveling member are abutted, an abutting member moving mechanism that moves one or both of the abutting members in the bending tool arranging direction with respect to the traveling member, a bending tool storage mount which is provided outside said bending machine main body along a traveling route for the traveling member and on which surplus bending tools not included in said bending tool group are placed in juxtaposition along said traveling route, an unloading pusher mechanism that pushes out the bending tools on said traveling member onto said bending tool storage mount, and a placing pusher mechanism that places any number of the bending tools on said bending tool storage mount onto said traveling member.
2. A bending machine with a bending tool length adjusting mechanism according to Claim 1, **character-**

ized in that said bending tool group on said traveling member has end-only bending tools positioned at opposite ends of said bending tool group, and an end of an arrangement of the bending tool group at a tip surface of the end-only bending tool constitutes a curved surface portion exhibiting a curved line in a cross section in the bending tool arranging direction, and in that said abutting member moving mechanism is able to move the end-only bending tool located farther from the bending machine main body, to a position where the end-only bending tool lies away from an end of a maximum arranging length of the bending tools on said bending tool storage mount.

3. A bending machine with a bending tool length adjusting mechanism according to Claim 1 or Claim 2, characterized in that said placing pusher mechanism comprises a plurality of push rods arranged in juxtaposition along bending tool arranging positions on said bending tool storage mount and at a position opposite to said traveling route, an endless pivoting member located opposite said traveling route so that a pivoting route for the endless pivoting member extends along an arrangement of the push rods, a pivoting member moving forward and backward mechanism that moves the endless pivoting member forward and backward toward said push rods, and a plurality of selective pushing members which are provided in a part of said endless pivoting member in a length direction thereof and in juxtaposition in the length direction, the selective pushing members pushing said push rods as a result of movement of said endless pivoting member carried out by said pivoting member moving forward and backward mechanism.

FIGURE 1

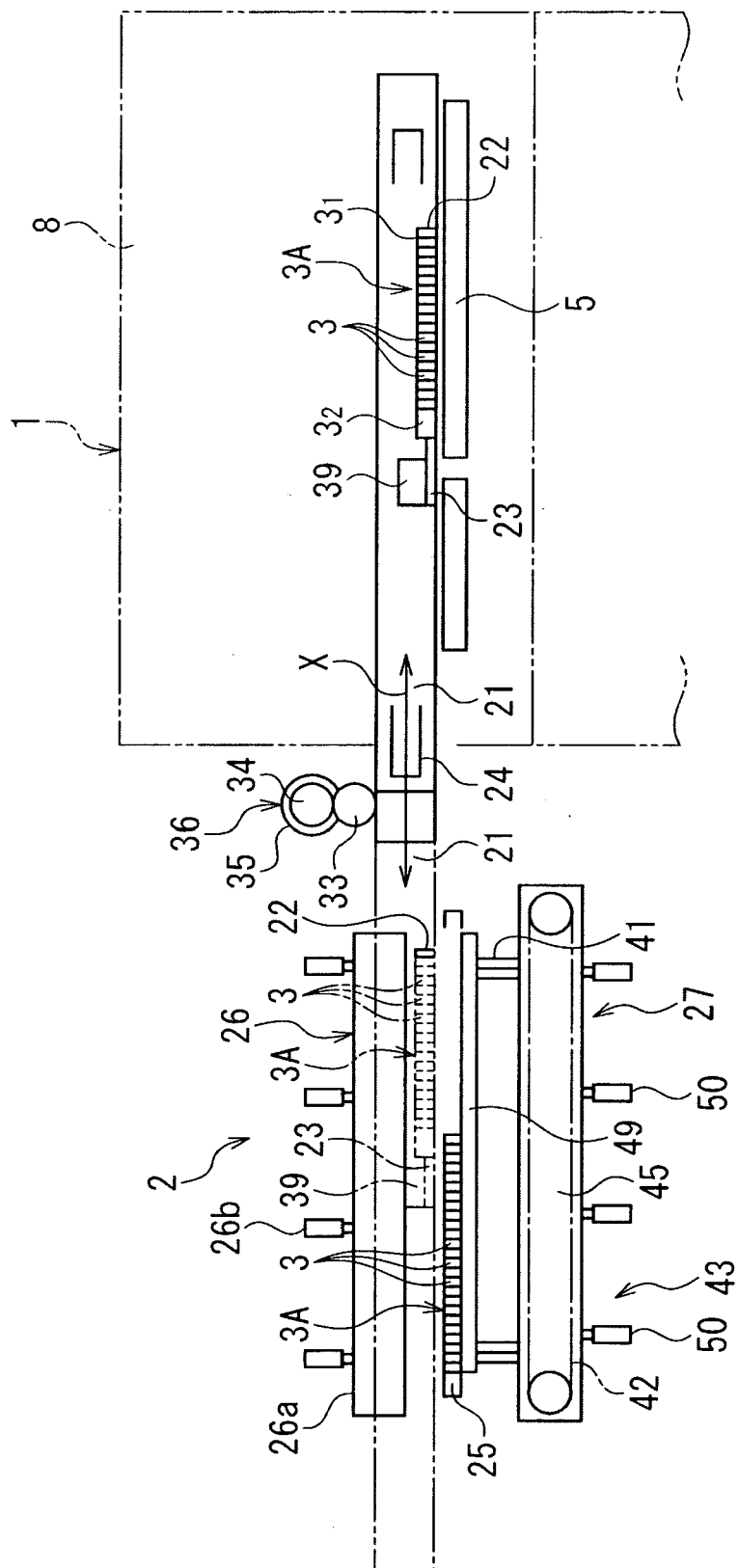


FIGURE 2

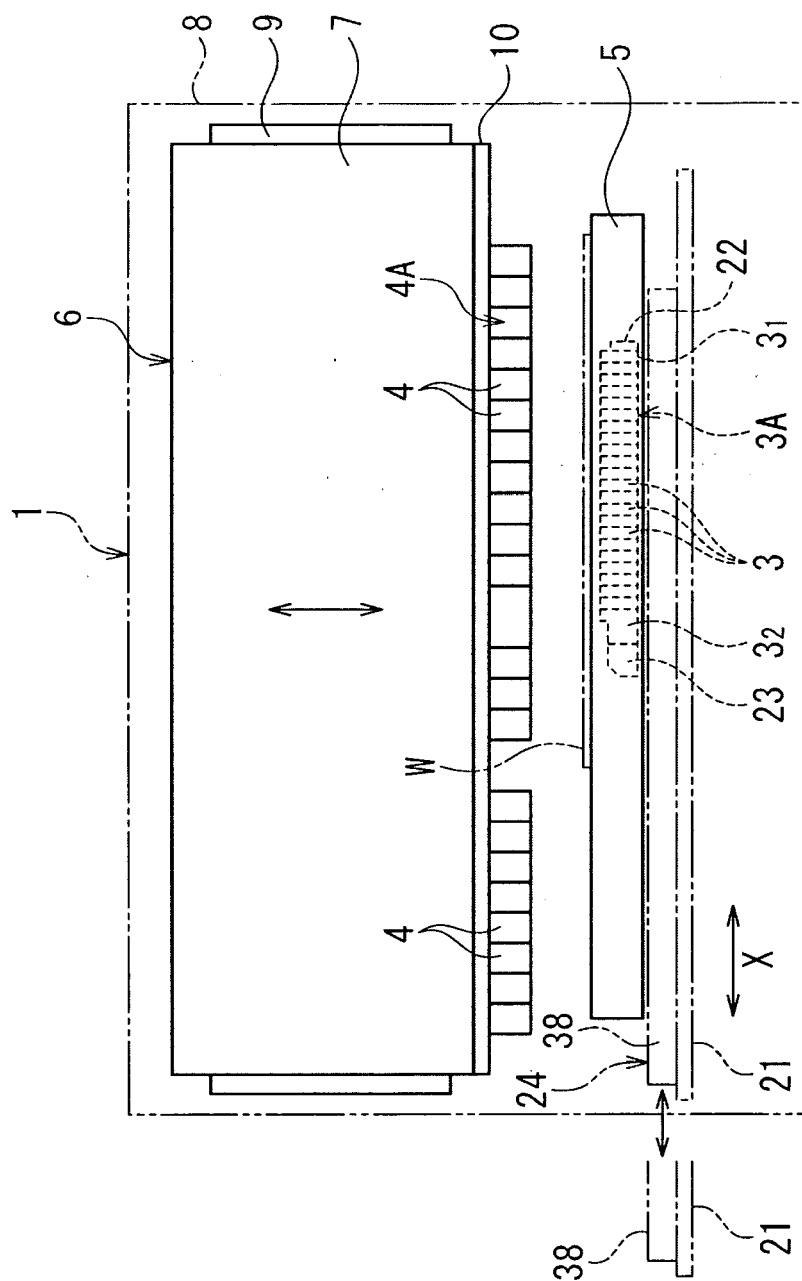


FIGURE 3

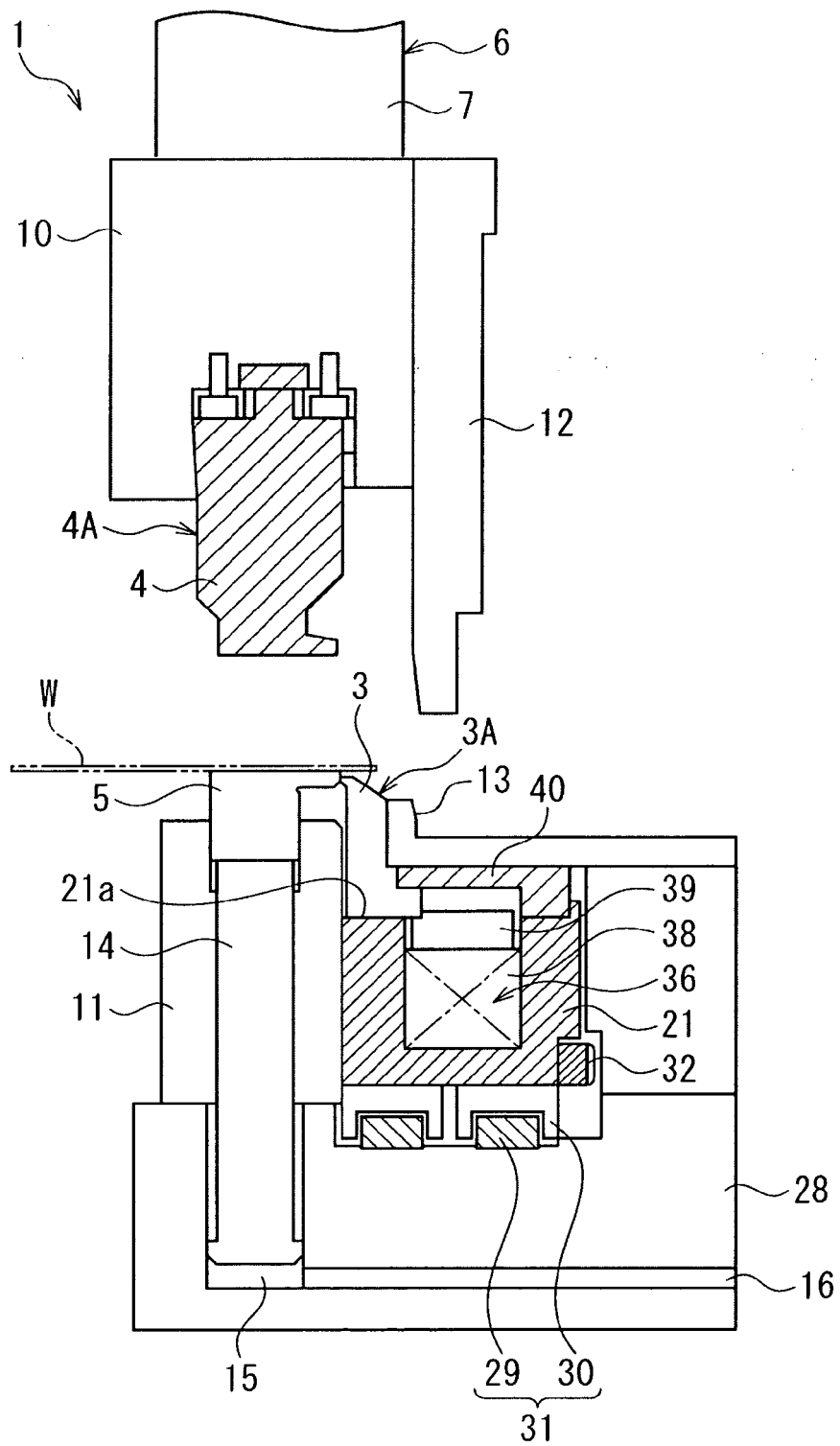


FIGURE 4A

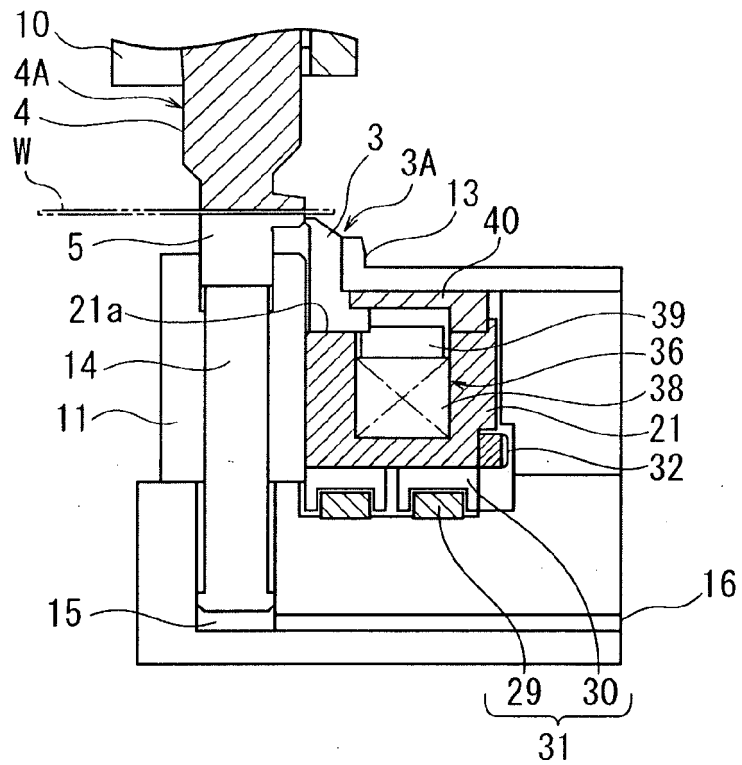


FIGURE 4B

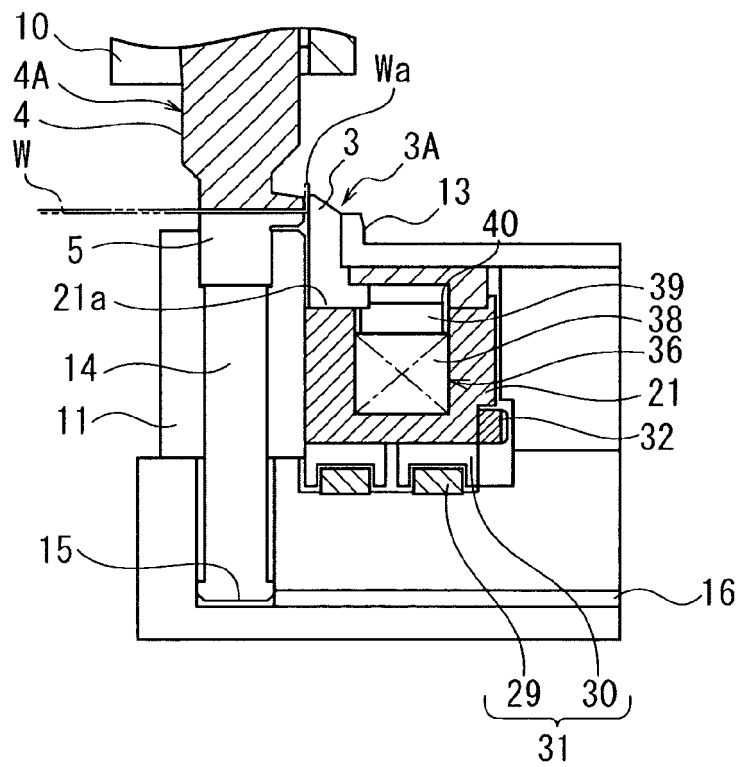


FIGURE 5

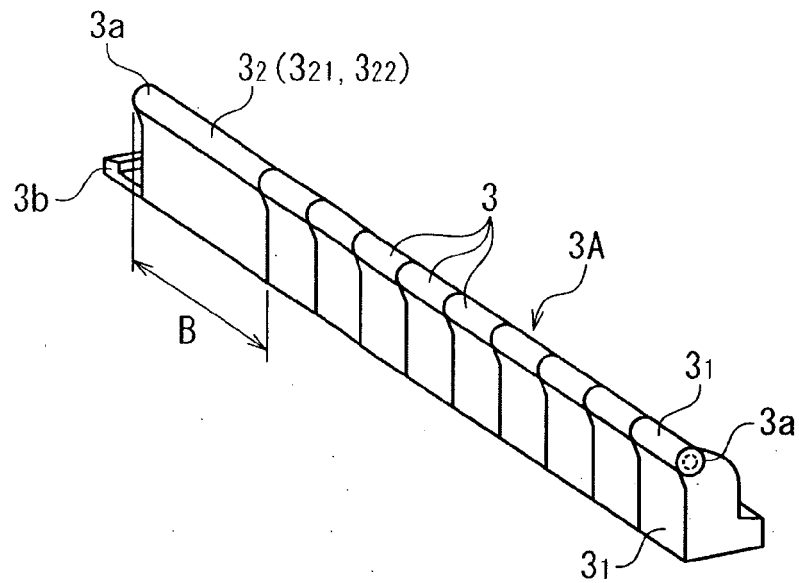


FIGURE 6

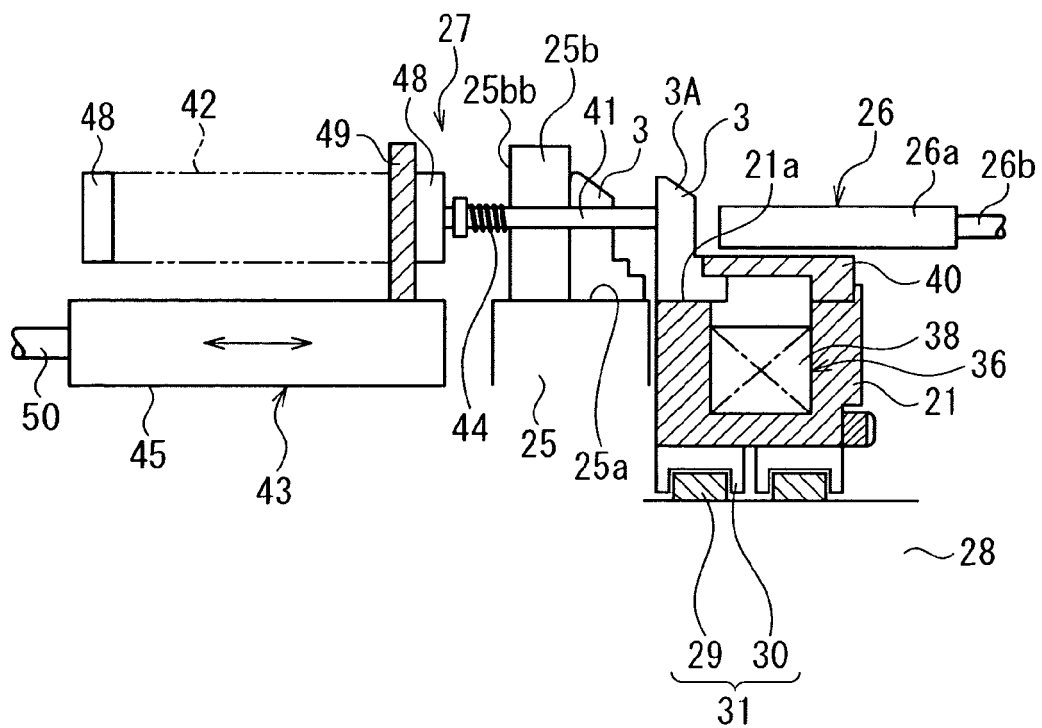


FIGURE 7

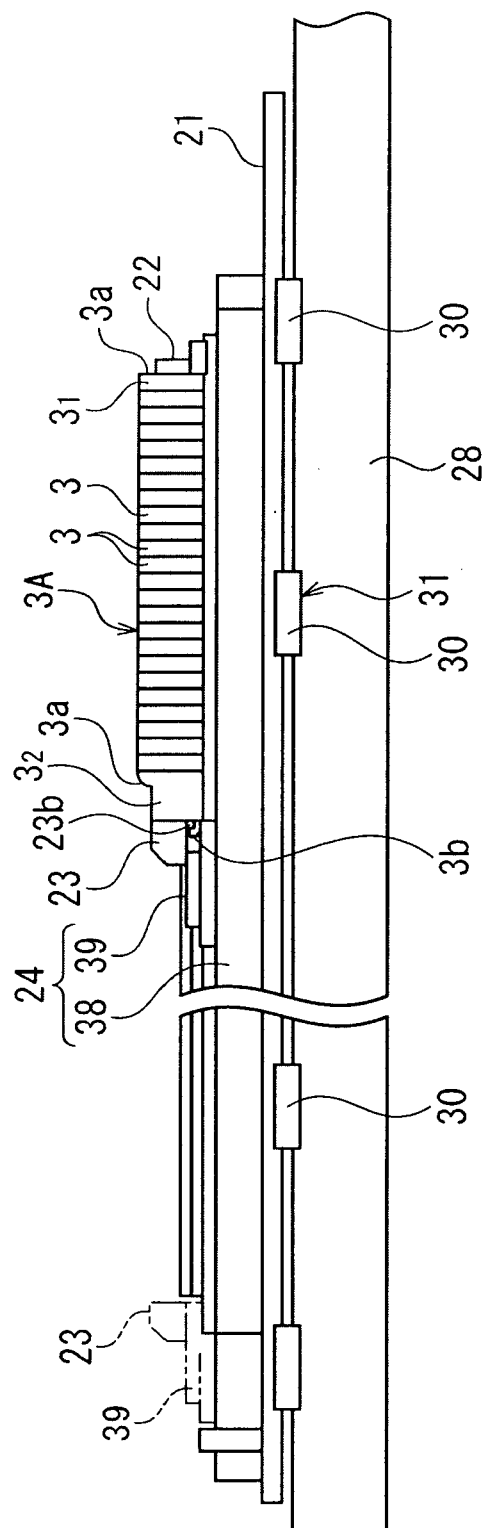


FIGURE 8

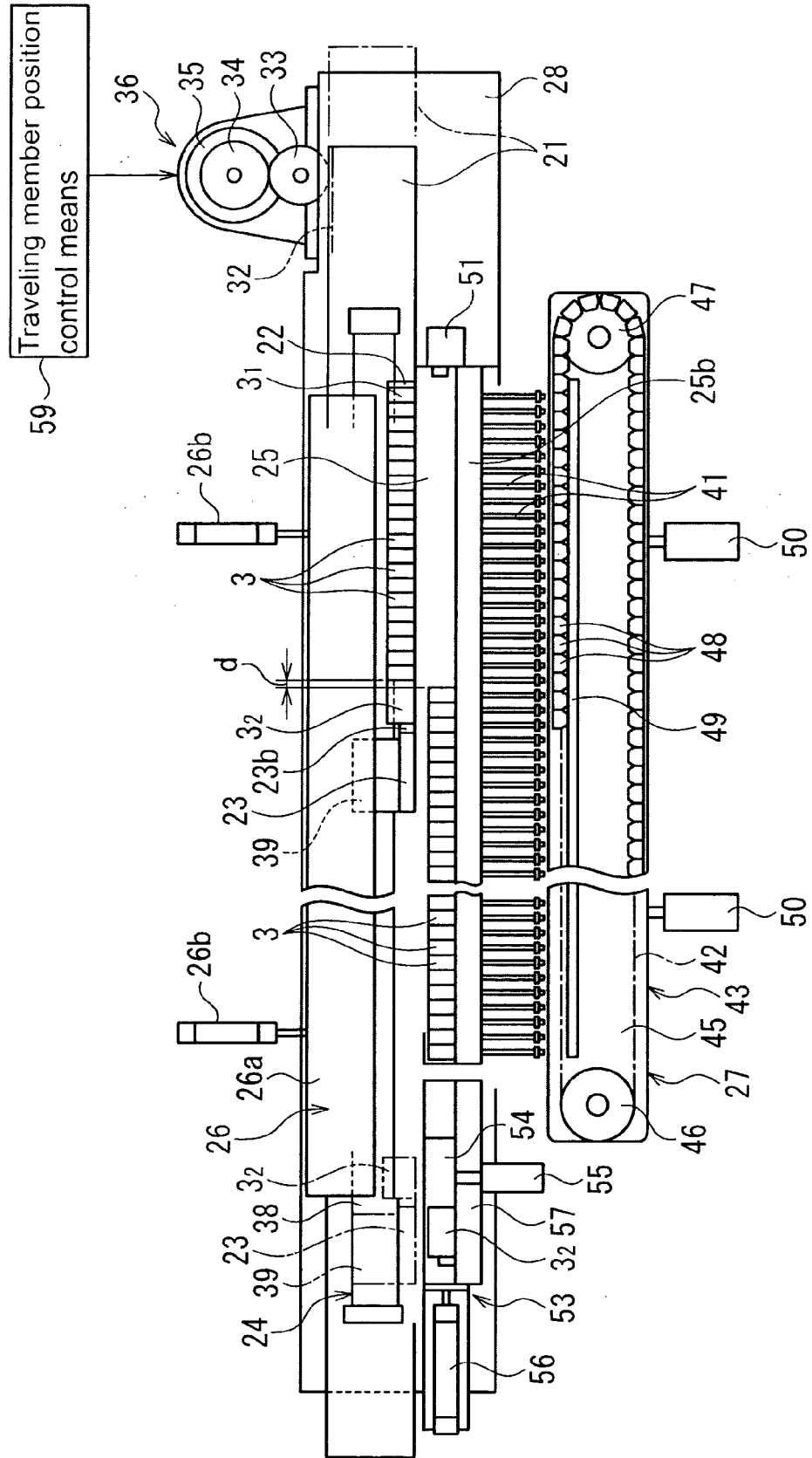


FIGURE 9

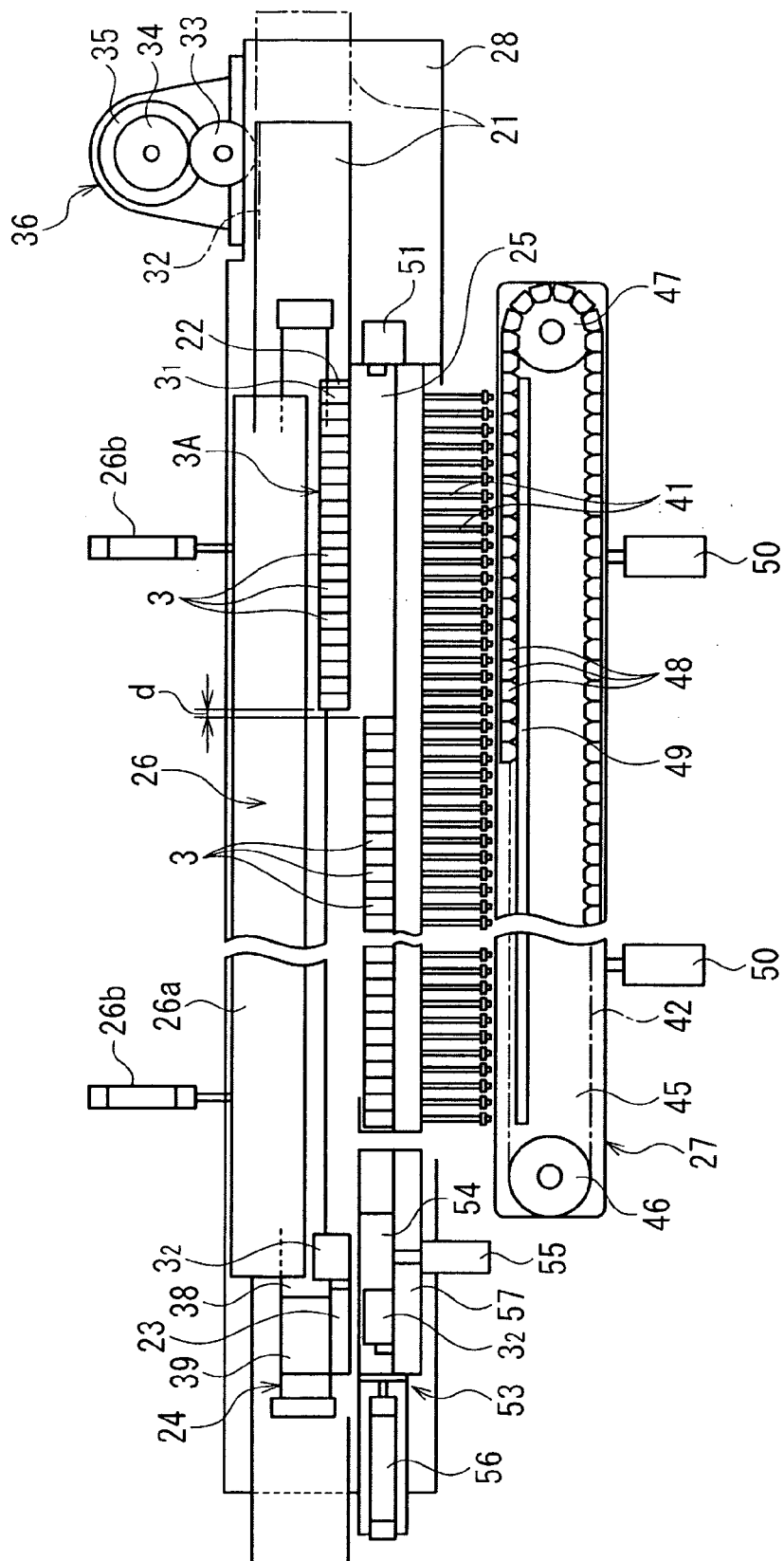


FIGURE 10

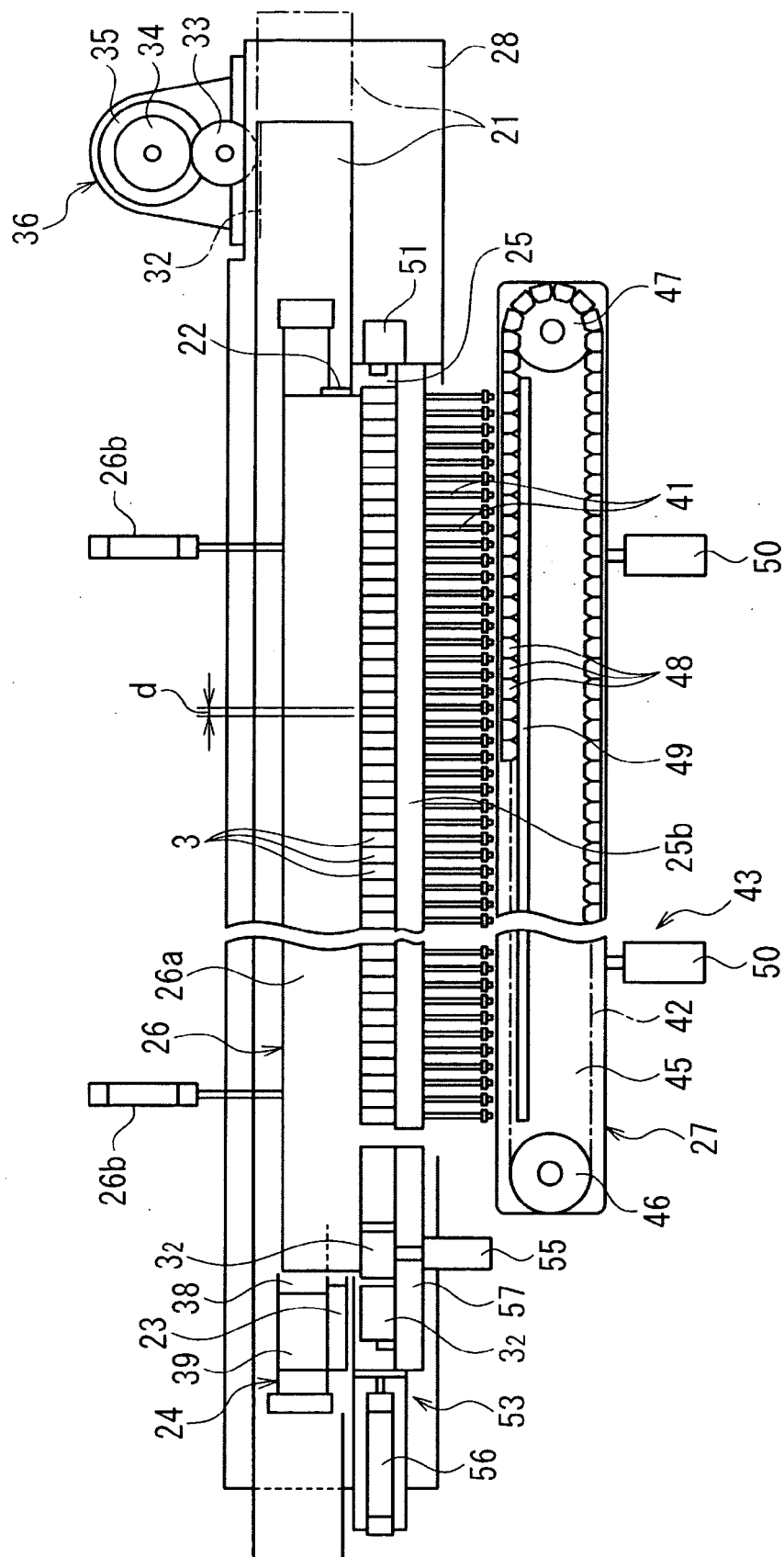


FIGURE 11

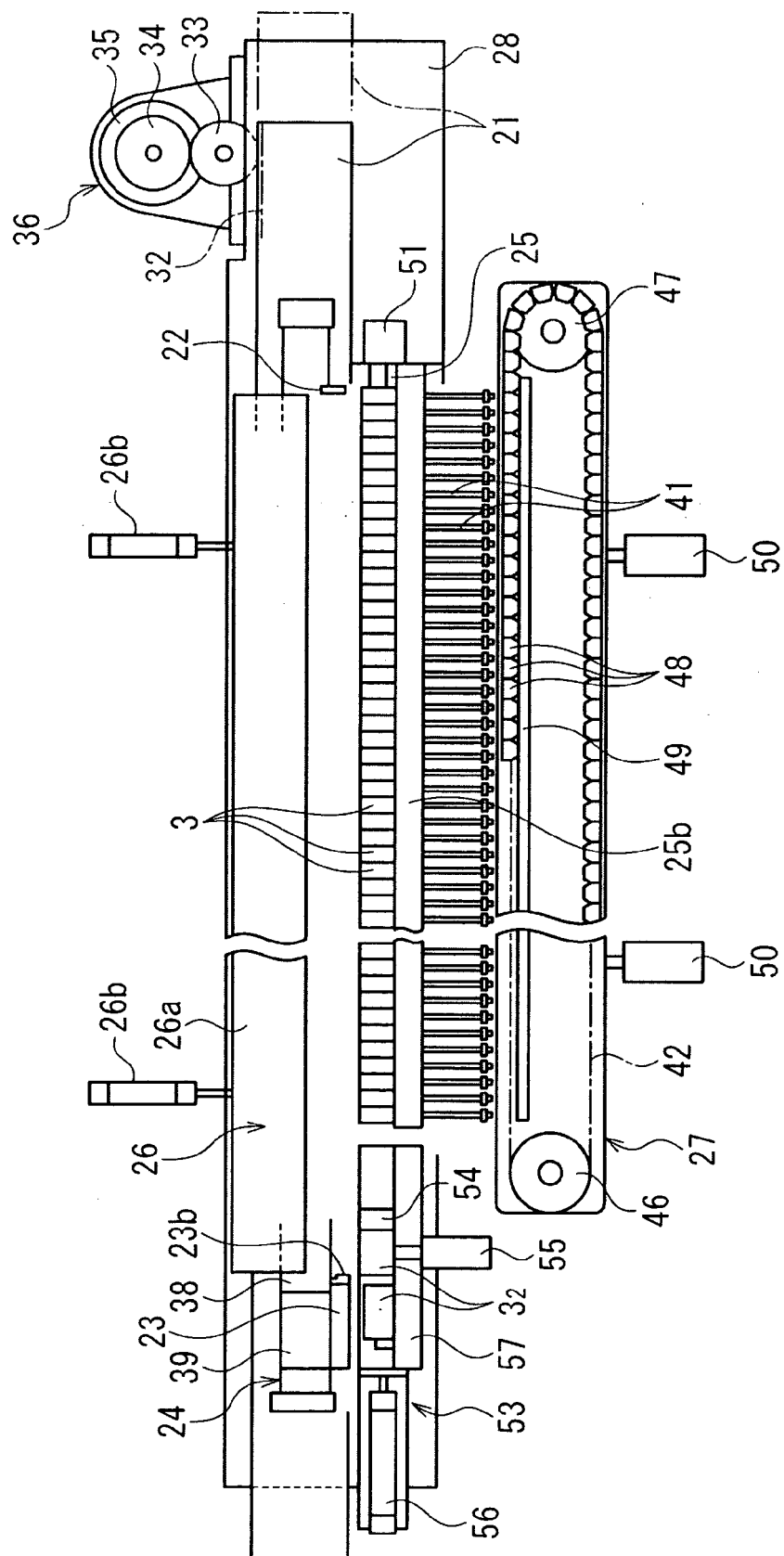


FIGURE 12

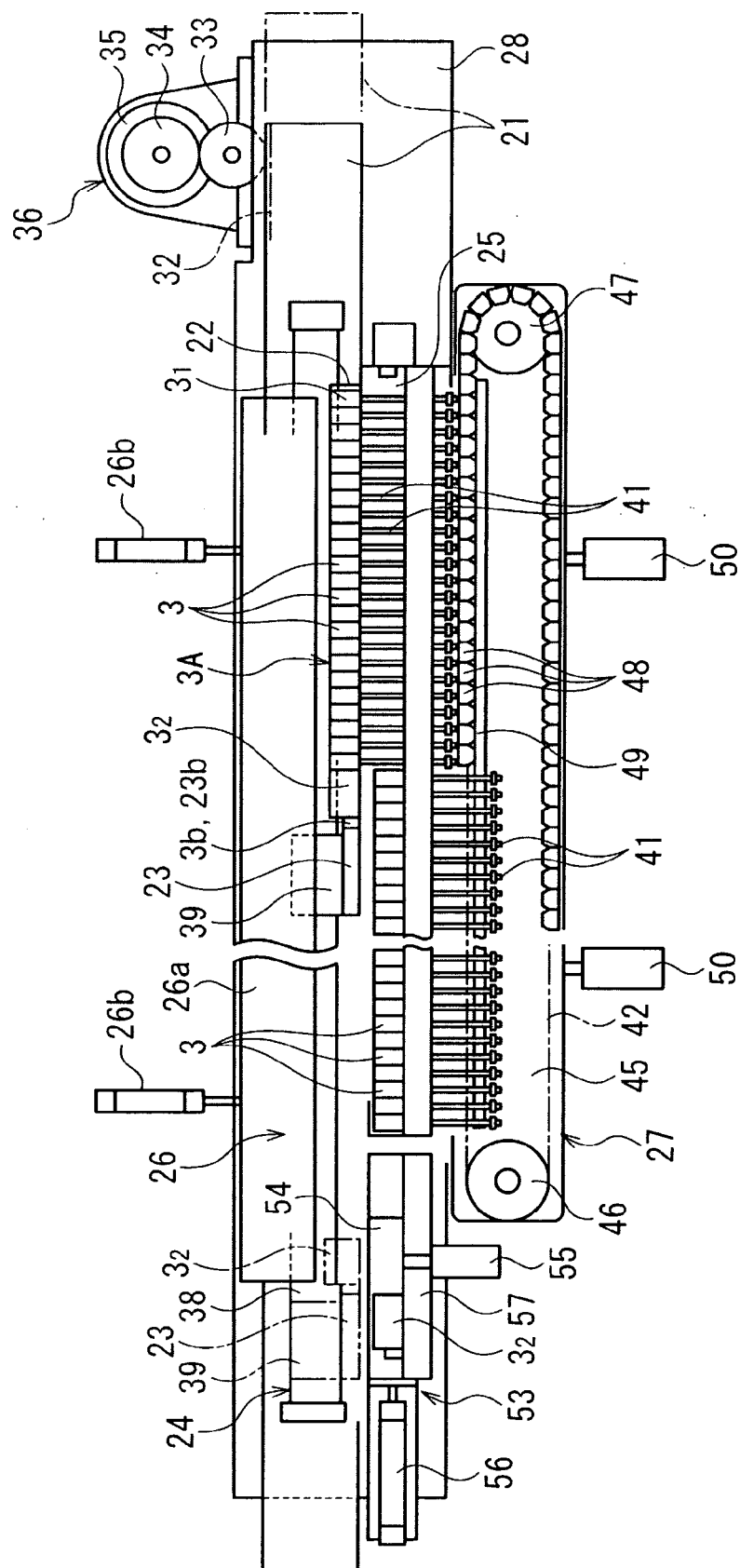


FIGURE 13A

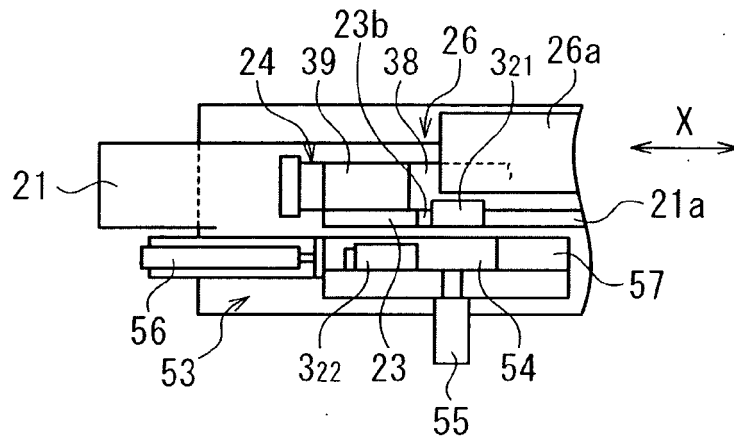


FIGURE 13B

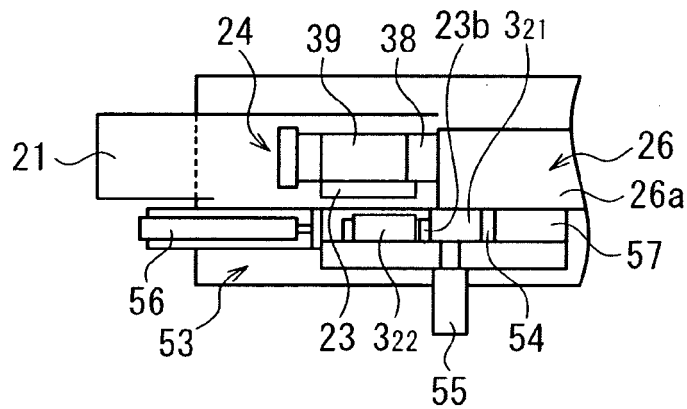


FIGURE 13C

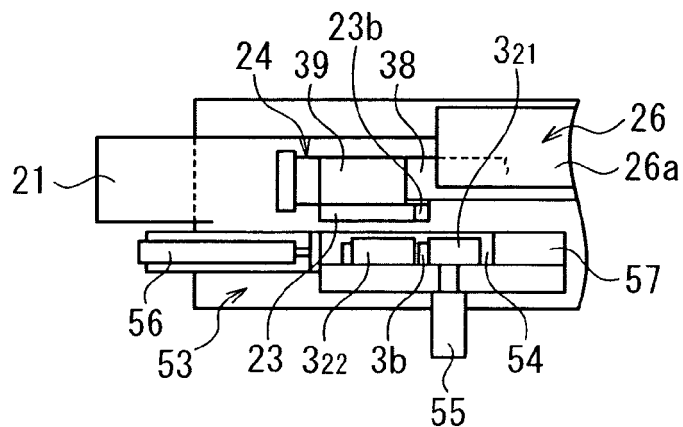


FIGURE 13D

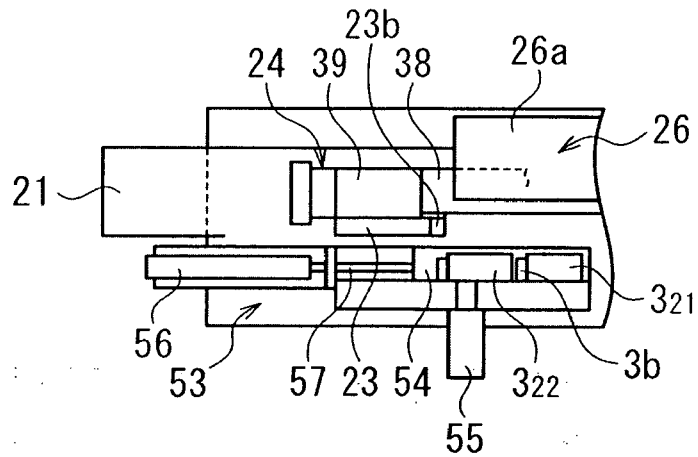


FIGURE 13E

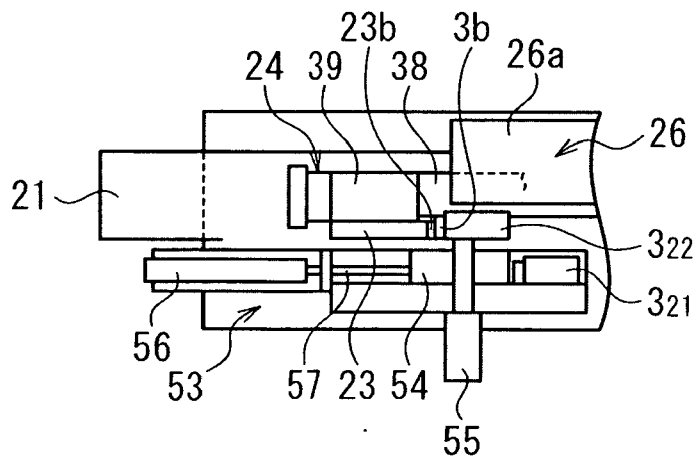


FIGURE 14

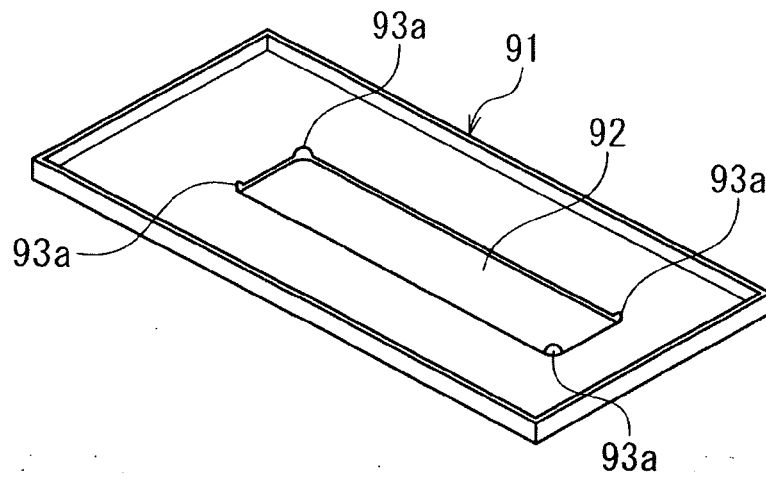


FIGURE 15

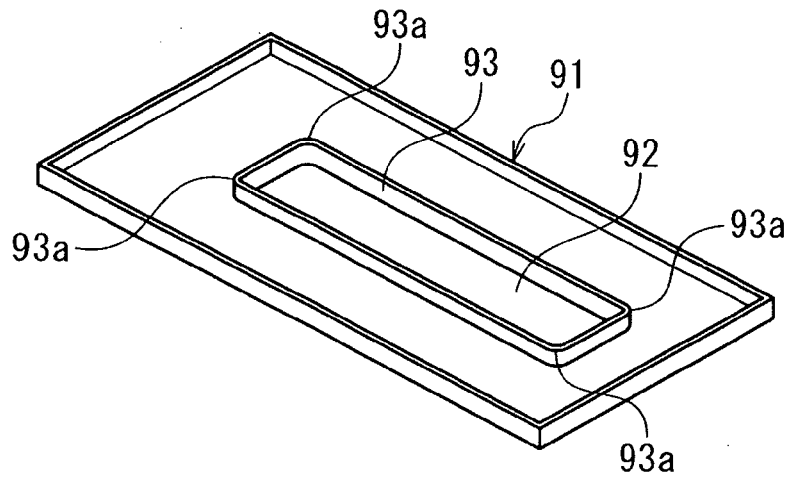
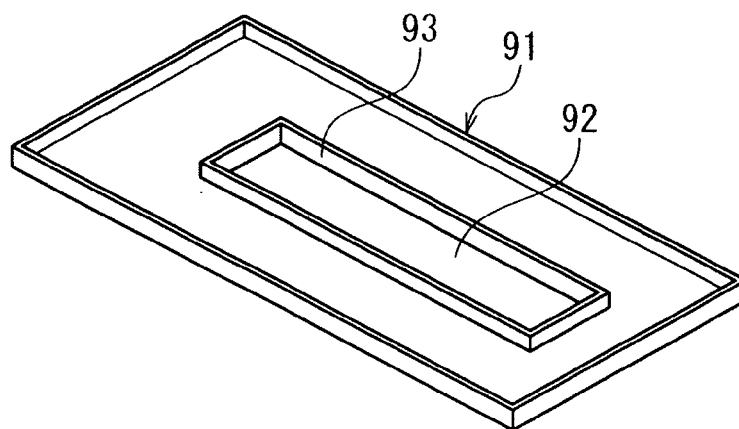


FIGURE 16





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 01 9369

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Place of search Munich		Date of completion of the search 5 March 2008	Examiner Vinci, Vincenzo
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3
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