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(72) Inventors:
• **Muraoka, Hideaki c/o Seiko Corporation
Shimizuoka-ken (JP)**
• **Tsuchiya, Hideo c/o Seiko Corporation
Shizuoka-ken (JP)**

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(74) Representative:
**Siekman, Gunnar, Dipl.-Phys. et al
Koppelstrasse 3
26135 Oldenburg (DE)**

(71) Applicant: **SEIKO CORPORATION
Shimizu-shi, Shizuoka-ken (JP)**

(54) **Linear capper and capping method**

(57) A linear capper (2) is provided with a piece unit transport mechanism (52). This mechanism (52) transports a scratch piece unit (60) between a cap-receiving position and a setting position in a substantially horizontal plane. The cap-receiving position is a position where the caps (48) are sequentially transferred from the terminating end of the cap transport passage (50) to the scratch pieces (58) of the scratch piece unit (60). The setting position is a position where the scratch piece unit (60) is set above the conveyor (6). A scratch piece unit (60) is on the scratch piece transport mechanism (52). The scratch piece unit (60) moves after an operation unit (18), which moves in accordance with the movement of the conveyor (6). The scratch piece unit (60) is movable in the conveying direction of the conveyor (6), the direction opposite to the conveying direction, and the direction orthogonal to the conveying direction.

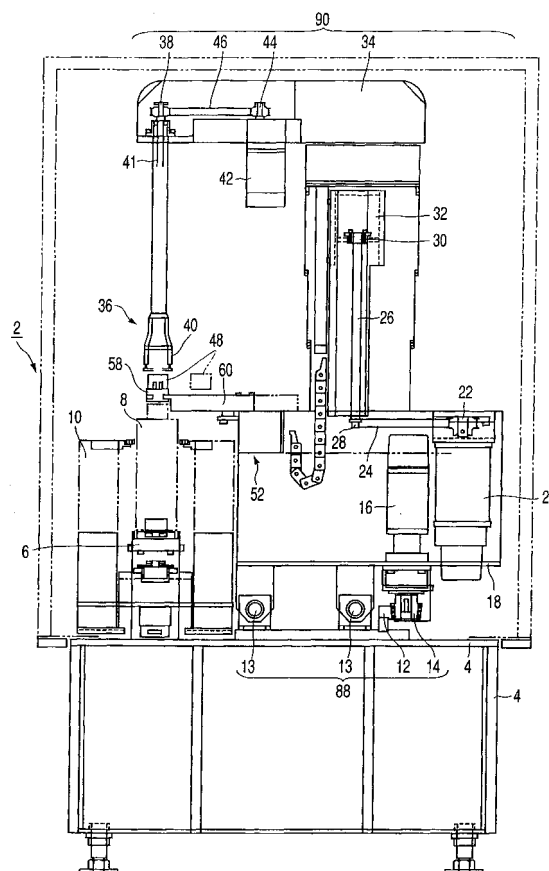


FIG. 1

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Description

[0001] The present invention relates to a linear capper which automatically caps receptacles arranged on a conveyor, and to a capping method used by the capper.

[0002] Jpn. Pat. Appln. KOKOKU Publication No. 4-59233 discloses a capper described below.

[0003] The capper comprises: a cap shoot which causes caps supplied from a cap supply section to fall freely along an inclined plane; and capping chucks which chuck the caps. The capper also comprises a scratch piece unit which moves the caps from the cap shoot to the capping chucks. The scratch piece unit is movable between a position which is near the cap shoot and a position which is away from it.

[0004] When a scratch piece moves a rod out of a cylinder device, a movable plate comes to a position above the receptacles by means of a lever and a swingable arm. At the time, the arm of the scratch piece is held horizontal because of its own weight. After the rod is moved out of the cylinder device, an operation arm lowers an operation cam. A cam follower swings down, with a pin as a shaft. In addition, the arm of the scratch piece unit, namely the scratch pieces, swings in a predetermined direction.

[0005] In a state where the scratch piece is raised, the caps are carried to the terminating end of the cap shoot. After being sequentially caught, the caps are returned to their original positions.

[0006] When the movable cam and the cam follower separate from each other, the arm of the scratch piece unit, namely the scratch piece, swings with the pin as a shaft because of its own weight. Then, the scratch piece is returned into the horizontal state. The capping head moves down, then the cap on the scratch piece is chucked, and then the capping head moves up. After a rod is pulled from the cylinder device, the movable plate gets off above the receptacles by means of the lever and the swinging arm. Subsequently, the capping head moves down, and the receptacles are capped.

[0007] In the technology shown in Jpn. Pat. Appln. KOKOKU Publication No. 4-59233, the scratch piece moves (swings) up or down. Depending upon the weight of the scratch piece, the swinging motion may result in the cap position being shifted from the right position.

[0008] Furthermore, many movable units, such as a vertically movable member and a motor, are arranged above the receptacles. With this structure, it may happen that some member will fall or the abraded particles of the units will attach to the surface of the receptacles or enter the interior of the receptacles.

[0009] The present invention has been conceived in an effort to solve the above problems, and the object of the invention is to provide a linear capper and a capping method which reliably arranges caps at the intended positions and which prevents the components from falling or reduces the amount of abraded particles.

[0010] To achieve the above object, the linear capper

according to the present invention comprises:

a conveyor which sequentially conveys a plurality of receptacles at a constant rate;

a cap transport passage along which caps for the receptacles are supplied;

a piece unit in which a plurality of scratch pieces for receiving the caps are arranged in the same plane in such a manner that one array or a number of parallel arrays are formed;

a piece unit transport mechanism which transports a piece unit between a cap-receiving position and a setting position in a substantially horizontal plane, the cap-receiving position being a position where the caps are sequentially transferred from a terminating end of the cap transport passage to pieces of the piece unit, and the setting position being a position where the piece unit is set above the conveyor;

a plurality of capping chucks arranged in one or more arrays in a direction in which the receptacles are fed, the capping chucks chucking the caps mounted on the piece unit in a state where the piece unit is located at the setting position and above the conveyor; and

chuck driving means for vertically driving the chucks, the chuck driving means lowering the chucks from a standby position, which is above the piece unit, to a capping position where the receptacles are capped, when the piece unit separates from the conveyor, the chuck driving means capping the receptacles while moving in such a manner as to follow the conveyor.

[0011] In a capping method provided by the present invention, a conveyor sequentially conveys a plurality of receptacles at a constant rate, caps for the receptacles are first supplied along a cap transport passage and then sequentially transferred from a terminating end of the cap transport passage onto a piece unit wherein a plurality of scratch pieces are arranged in such a manner as to form one array or a number of arrays, the piece unit is moved to a position above the conveyor, and the caps mounted on pieces of the piece unit are chucked by capping chucks and attached to the receptacles, for capping, the capping method comprising:

a step of moving the piece unit to a position below the capping chucks in a substantially horizontal plane until the caps and the capping chucks are substantially aligned;

a step of lowering the capping chucks until the capping chucks chuck the caps;

a step of moving the capping chucks upward and thereafter moving the piece unit away from a position where the piece unit is below the capping chucks and the caps on the piece unit are aligned with the capping chucks;

a step of capping the receptacles while moving the capping chucks down; and
 a step of opening the capping chucks, separating the capping chucks from the caps, and moving the capping chucks upward.

[0012] This summary of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

[0013] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic front view of a linear capper according to one embodiment of the present invention.

FIG. 2A is a schematic plan view of the linear capper depicted in FIG. 1.

FIG. 2B is a schematic diagram showing how the positional relationships of a scratch piece unit and scratch pieces are relative to a cap shoot.

FIG. 3A is a schematic plan view of a scratch piece transport mechanism which the embodiment uses for moving the scratch piece unit.

FIG. 3B is a schematic side view of what FIG. 3A shows.

FIG. 4 is a schematic front view of a gripper, which is employed in the linear capper shown in FIG. 1.

FIG. 5 is a schematic plan view of the gripper shown in FIG. 4.

FIG. 6 is a schematic side view of the gripper shown in FIGS. 4 and 5.

FIG. 7 is a diagram illustrating how the positional relationship of the scratch piece unit to a conveyor is in a horizontal plane.

FIG. 8A shows a schematic plan view illustrating how the scratch piece unit and capping chucks are in one state, and also shows a schematic side view of them.

FIG. 8B shows a schematic plan view illustrating how the scratch piece unit and the capping chucks are in another state, and also shows a schematic side view of them.

FIG. 9A shows a schematic plan view illustrating how the scratch piece unit and the capping chucks are in another state, and also shows a schematic side view of them.

FIG. 9B shows a schematic plan view illustrating how the scratch piece unit and the capping chucks are in another state, and also shows a schematic side view of them.

FIG. 9C shows a schematic plan view illustrating how the scratch piece unit and the capping chucks are in another state, and also shows a schematic side view of them.

[0014] An embodiment of the present invention will

now be described with reference to the accompanying drawings.

[0015] As shown in FIG. 1, a capper 2 comprises a frame 4 that supports an operation unit 18 described later. As shown in FIG. 1 and 2A, a linear conveyor 6 is provided on the frame 4. Receptacles 8 are arranged on the conveyor 6 at predetermined intervals (pitches). In this state, the conveyor 6 is driven at a constant speed.

[0016] A rack 12 and a pair of parallel support rods 13 are provided on the frame 4 and extend in parallel to the conveying direction of the conveyor 6. The operation unit 18 is on the support rods 13 and is slidable along it. The operation unit 18 is provided with a first servo motor 16, and the driving shaft of this servo motor extends downward. As shown in FIG. 1, a pinion 14 is attached to the driving shaft. The pinion 14 is in engagement with the rack 12. In this manner, an operation unit-moving means 88 is formed.

[0017] The operation unit-moving means 88 operates as below. When the first servo motor 16 rotates in a predetermined direction, the torque generated thereby is transmitted to the pinion 14. By the rotation of this pinion 14, the operation unit 18 bearing the first servo motor 16 thereon linearly moves along the rack 12 and the support rods 13.

[0018] When the first servo motor 16 rotates in the reverse direction, the operation unit 18 moves substantially linearly in the direction opposite to the conveying direction of the conveyor 6. In other words, the operation unit 18 moves back and forth along the rack 12 and support rods 13 within a predetermined range of the frame 4.

[0019] The moving speed of the operation unit 18 is under the feedback control by the first servo motor 16. By this feedback control, the moving speed of the operation unit 18 can be controlled in accordance with the conveying speed of the conveyor 6. When the pinion 14 has reached a predetermined position at one end of the rack 12, the first servo motor 16 is stopped temporarily. The subsequent operation is optional—the first servo motor 16 may remain at rest or may be driven in the opposite direction. In other words, the operation unit 18 moves in two directions: one is the same as the conveying direction of the conveyor 6, and the other is opposite to that conveying direction. In either case, the moving speed of the operation unit 18 may be equal to, or greatly different from the driving speed of the conveyor 6. For example, the moving speed of the operation unit 18 can be arbitrarily controlled on the basis of the intervals at which the receptacles are arranged on the conveyor 6.

[0020] The operation unit 18 is also provided with a second servo motor 20 adjacent to the first servo motor 16. The driving shaft of this servo motor 20 is projected in the opposite direction to that of the first servo motor 16. That is, it extends upward in the operation unit 18. A timing pulley 22 is attached to the driving shaft of the second servo motor 20.

[0021] A ball screw 26 is located above the operation unit 18. The lower end of the ball screw 26 is substantially at the same level as the timing pulley 22 attached to the driving shaft of the second servo motor 20. A timing pulley 28 is attached to the lower end of the ball screw 26. A timing belt 24 is wound around both the timing pulley 28 and the timing pulley 22 of the second servo motor 20.

[0022] A bearing 30 is provided at the upper end of the ball screw 26. A base member 32 provided for the operation unit 18 is coupled to the base member 32 through the bearing 30. When the ball screw 26 rotates, this rotation causes the base member 32 to move linearly.

[0023] The rear end portion of a capping head 34 is located above the base member 32. As shown in FIG. 2A, the front end portion of the capping head 34 is provided with three capping chucks 36. These capping chucks 36 are linearly arranged above the line of the conveyor 6 and extend downward. A timing pulley 38 is provided at the upper end of each capping chuck 36.

[0024] Three motors 42, preferably servo motors, are located between the front and rear ends of the capping head 34. These motors 42 are arranged linearly and have their driving shafts projected upward. A timing pulley 44 is attached to each driving shaft. A timing belt 46 is wound around each timing pulley 44 and the corresponding one of the timing pulleys 38 at the upper end of the capping chuck 36.

[0025] The lower end of the capping chuck 36 is a chuck portion 40 which is openable/closable and rotatable. A spindle 41 is provided between the upper and lower ends of the capping chuck 36. In this manner, a chuck driving means 90 is formed.

[0026] The chuck driving means 90 operates as follows. When the second servo motor 20 rotates, the torque is transmitted to the timing pulley 22, and then to the timing belt 24 which is in engagement with the timing pulley 22. This torque is transmitted to the ball screw 26 through the timing pulley 28. The rotation of the ball screw 26 causes the base member 32 to linearly move in the vertical direction. The capping head 34 attached to the base member 32 is raised or lowered in accordance with the vertical movement of the base member 32, so that the capping chuck 36 linearly moves in the vertical direction. When the capping chuck 36 moves, its moving distance is determined based on the feedback control of the second servo motor 20. The moving speed of the capping chuck 36 can be controlled in association with the operation of a scratch piece transport mechanism 52.

[0027] When the motor 42 adjacent to the capping head 34 is driven, the torque of the motor 42 is transmitted to the timing belt 46 through the timing pulley 44. The torque is then transmitted to the spindle 41 through the timing pulley 38, thereby rotating the spindle 41. As a result, the chuck portion 40 at the lower end of the capping chuck 36 is rotated. The torque applied by the

chuck portion 40 is determined by controlling the motor 42. Therefore, when caps 48 are attached to receptacles 8, the tightened state of the caps 48 can be optimally controlled.

[0028] The stroke of the capping chuck 36, i.e., the distance for which the capping chuck 36 linearly moves in the vertical direction, can be freely determined. In addition, the rotation of the capping chuck 36 can be determined in such a manner that the caps 48 are secured to the receptacles 8 with an appropriate force.

[0029] As shown in FIGS. 2A and 2B, the frame 4 is provided with a cap transport passage 50 (a cap shoot) for successively supplying the caps 48. The cap transport passage 50 is disposed above the upper surface of the frame 4 in such a manner that its terminating end is along the conveying direction of the conveyor 6.

[0030] The caps 48 are sequentially supplied from a cap supply section (not shown) to the cap transport passage 50. In the state where the caps 48 are in mutual contact, the caps 48 slide down in a line along the cap transport passage 50 and come to the terminating end of the cap transport passage 50. A scratch piece unit 60, which is parallel to the upper surface of the frame 4, is located in the neighborhood of the terminating end of the cap transport passage 50. The scratch piece unit 60 has three scratch pieces 58. At the terminating end of the cap transport passage 50, the caps 48 come into engagement with the scratch pieces 58 one by one.

[0031] The scratch piece unit 60 is provided with a scratch piece transport mechanism 52. The scratch piece unit 60 is movably supported by this transport mechanism 52. As shown in FIGS. 3A and 3B, the scratch piece transport mechanism 52 includes a first base 54 and a second base 56, both of which are rectangular. The first and second bases 54 and 56 cross at right angles and form a substantially "T"-shaped structure. A first axially moving means 84 extends in the longitudinal direction (X-axis direction) of the first base 54. Likewise, a second axially moving means 86 extends in the longitudinal direction (Y-axis direction) of the second base 56.

[0032] The first axially moving means 84 of the first base 54 includes a first linearly guiding device 62 (a first guide section) in the form of a rail. This rail extends in an X-axis direction. The X-axis direction is parallel to the conveying direction of the conveyor 6. A first ball screw 64 extends along the longitudinal center of the first linearly guiding device 62. A first slider 66 is provided for the first ball screw 64 and first linearly guiding device 62. The first slider 66 penetrates the first ball screw 64 and is in threadable engagement therewith. The first slider 66 is slidably coupled to the first linearly guiding device 62 (which is a rail).

[0033] A first servo motor 68 is coupled to one end of the first ball screw 64. When the first servo motor rotates in a predetermined direction, the torque produced thereby rotates the first ball screw 64. The rotation of the first ball screw 64 causes the first slider 66 to linearly slide

along the first linearly guiding device 62 in the conveying direction of the conveyor 6. On the other hand, when the first servo motor 68 rotates in the direction opposite to the predetermined direction, the torque produced thereby rotates the first ball screw 64 in the opposite direction. This rotation of the first ball screw 64 causes the first slider 66 to linearly slide along the first linearly guiding device 62 in the direction opposite to the conveying direction of the conveyor 6.

[0034] The second axially moving means 86 of the second base 56 includes a second linearly guiding device 70 (a second guide section) in the form of a rail. This rail extends in a Y-axis direction. The Y-axis direction is orthogonal to the conveying direction of the conveyor 6. A second ball screw 72 extends along the longitudinal center of the second linearly guiding device 70. A second slider 74 is provided for the second ball screw 72 and second linearly guiding device 70. The second ball screw 72 penetrates the second slider 74 and is in threadable engagement therewith. The second slider 74 is slidably coupled to the second linearly guiding device 70 (which is a rail). A cam follower 78 (an engagement member) is attached to the second slider 74.

[0035] A second servo motor 76 is coupled to one end of the second ball screw 72. When the second servo motor rotates in a predetermined direction, the torque produced thereby rotates the second ball screw 74. The rotation of the second ball screw 74 causes the second slider 74 to linearly slide along the second linearly guiding device 70 in a direction approaching the first base 54. On the other hand, when the second servo motor 76 rotates in the direction opposite to the predetermined direction, the torque produced thereby rotates the second ball screw 72 in the opposite direction. This rotation of the second ball screw 72 causes the second slider 74 to linearly slide along the second linearly guiding device 70 in the direction away from the first base 54.

[0036] As shown in FIG. 3B, the scratch piece unit 60 and the first slider 66 are connected together. A pair of parallel rods 80, extending in parallel in the X-axis direction, are disposed on the lower surface of the scratch piece unit 60, as can be seen from FIGS. 3A and 3B. The cam follower 78 described above is sandwiched between the parallel rods 80 and in engagement with the scratch piece unit 60.

[0037] The cam follower 78 moves in such a manner as to follow the second slider 74. Therefore, when the second slider 74 moves in the Y-axis direction, the scratch piece unit 60 also moves in the same direction. When the scratch piece unit 60 moves in the X-axis direction, it moves along the parallel rods 80 in such a manner as to follow the first slider 66.

[0038] When the scratch piece transport mechanism 52 moves in the conveying direction of the conveyor 6, it approaches the terminating end of the cap transport passage 50. During this movement, the scratch piece transport mechanism 52 comes to a reception position where the scratch pieces 58 come into engagement with

the caps 48. When the scratch piece transport mechanism 52 moves in the Y-axis direction, it comes to a setting position which is under the capping chucks 36 and coaxial therewith, in the state where the caps 48 are mounted on the scratch pieces 58. The setting position is a position where the caps 48 are chucked and transferred to the chuck portions 40 of the capping chucks 36.

[0039] As can be seen from the above, the scratch piece transport mechanism 52 is movable in two directions within a predetermined horizontal range, one direction being the X-axis direction which is along the conveying direction of the conveyor 6, and the other direction being the Y-axis direction orthogonal to the conveying direction of the conveyor 6.

[0040] In the above embodiment, the cam follower 78 was described as an engagement member disposed between the scratch piece unit 60 and the second slider 74. However, the cam follower 78 may be replaced with a bearing or another member formed of resin or brass as long as the alternative member allows the scratch piece unit 60 to move in a predetermined direction.

[0041] When the cap 2 caps the receptacles 8 arranged on the conveyor 6, grippers 10 shown in FIG. 2A hold the receptacles 8 one by one. As shown in FIG. 2A, the grippers 10 arranged on the conveyor 6 are three in number, like the capping chucks 36 and the scratch pieces 38.

[0042] As shown in FIGS. 4 through 6, each gripper 10 is provided with a guide section 92 which is formed as a rail. As shown in FIGS. 5 and 6, a pair of sliders 94, which are away from each other by a predetermined distance, are slidable along the guide section 92. A cylinder 96 is located between the sliders 94 and extends along the guide section 92. A joint 98 is attached to that one end of the cylinder 96. A pair of first links 100 are provided for the tip end of the joint 98. The first ends of these first links 100 are pivotally coupled to the joint 98 by means of a first pivotal coupling section 102. At the second ends, the first links 100 are connected to second links 106, respectively. The second ends of the first links 100 and the first ends of the second links 106 are pivotally coupled by means of second pivotal coupling sections 104. Third pivotal coupling sections 108 are provided at appropriate positions on the second links 106. The third pivotal coupling sections 108 are coupled to a base 113 shown in FIGS. 4 and 6. A pair of gripper bases 110 are connected to appropriate positions of the second links 106. Preferably, the gripper bases 110 are each shaped as "C" and face each other.

[0043] The cylinder 96 moves the joint 98 relative to the sliders 94 in the conveying direction of the conveyor 6, i.e., rightward as viewed in FIG. 5. This movement opens the first links 100. To be more specific, the angle formed by the first links 100 changes from acute to obtuse. In accordance with the opening movement of the first links 100, the second links 106 move, with the third pivotal coupling sections 108 as fulcrums. As a result, the second pivotal coupling sections 104 move away

from each other, and the gripper bases 110 move in the closing direction. In this manner, a receptacle 8 is held.

[0044] The cylinder 96 moves the joint 98 relative to the sliders 94 in the direction opposite to the conveying direction of the conveyor 6, i.e., leftward as viewed in FIG. 5. This movement closes the first links 100. To be more specific, the angle formed by the first links 100 becomes more acute. In accordance with the closing movement of the first links 100, the second links 106 move, with the third pivotal coupling sections 108 as fulcrums, in such a manner that the second pivotal coupling sections 104 move closer to each other. Accordingly, the gripper bases 110 move in the opening direction. In this manner, the receptacle 8 is released.

[0045] As can be seen from the above, the gripper bases 110 move to the receptacle 8 in such a manner that the movements of them are simultaneous and symmetric. As compared to the case where a single gripper base is provided, the movements of the gripper bases can be controlled with high accuracy. Since the receptacle 8 can be handled gently, the liquid in the receptacle 8 is prevented from gushing.

[0046] Each gripper 10 has a pair of brackets 112. These brackets 112 are attached to the operation unit 18, as shown in FIGS. 4 through 6. Therefore, when the operation unit 18 moves in the conveying direction of the conveyor 6, the gripper 10 moves in the same direction, following the operation unit 18. Conversely, when the operation unit 18 moves in the direction opposite to the conveying direction of the conveyor 6, the gripper 10 moves in the same direction (i.e., the direction opposite to the conveying direction of the conveyor 6), following the operation unit 18.

[0047] A description will be given as to how the capper 2 caps the receptacles 8, referring to FIGS. 7 through 9.

[0048] In FIG. 7, (a) illustrates how the caps 48 are sequentially transferred from the cap transport passage to the scratch piece unit 60, (b) illustrates how the scratch piece unit 60 is moved in the conveying direction of the conveyor 6, (c) illustrates how the scratch pieces 58 of the scratch piece unit 60 are arranged on the conveyance passage of the conveyor 6, and (d) illustrates how the scratch piece unit 60 is moved in the direction opposite to the conveying direction of the conveyor 6.

[0049] In FIG. 8A, (a) is a plan view illustrating how the scratch piece unit 60, which holds the caps 48 at the scratch pieces 58, is moved to the region below the capping chucks 36, and (b) is a side view of what is shown in (a). In FIG. 8B, (a) is a plan view illustrating how the scratch piece unit 60, which holds the capping chucks 36 at the scratch pieces 58, is located in the region below the capping chucks 36, and (b) is a side view of what is shown in (a).

[0050] In FIG. 9A, (a) is a plan view illustrating how the capping chucks 36 chuck the caps 48 mounted on the scratch pieces 58, and (b) is a side view of what is shown in (a). In FIG. 9B, (a) is a plan view illustrating how the caps 48 chucked by the capping chucks 36 are

moved upward from the scratch piece 58, and (b) is a side view of what is shown in (a). In FIG. 9C, (a) is a plan view illustrating how the scratch piece unit 60 is moved in the Y-axis direction from the position below the capping chucks 36, and (b) is a side view of what is shown in (a).

[0051] In the initial state of the capper 2 of the embodiment, the operation unit 18 is located at a position which is upstream with respect to the conveying direction of the conveyor 6 (i.e., the positive direction of the X axis). The caps 48 are at the terminating end of the cap transport passage 50 attached to the frame 4. The scratch piece unit 60 on the scratch piece transport mechanism 52 is at the upstream position and extends along the terminating end of the cap transport passage 50. The capping chucks 36 are in front of, and above the scratch piece unit 60. The chuck portions of the capping chucks 36 are in the open state and stationary (not rotating). The grippers 10 with which to grip the receptacles 8 are in the open state.

[0052] First of all, the receptacles 8 arranged at the predetermined intervals are fed downstream (in the positive direction of the X-axis) at a constant speed. Simultaneous with the conveyance by the conveyor 6, the first servo motor 16 is rotated. The operation unit 18 is moved downstream (in the positive direction of the X-axis) substantially at the same feeding speed as the conveyor 6. At the time, the scratch piece transport mechanism 52 is driven to move the scratch piece unit 60 to a position in the neighborhood of the terminating end of the cap transport passage 50. The scratch piece unit 60 moves to the downstream position of the conveyor 6 faster than the operation unit 18.

[0053] As shown in (a) of FIG. 7, the caps 48 are sequentially scratched with the scratch pieces 58 of the scratch piece unit 60. This scratching operation is executed beginning with the terminating end of the cap transport passage 50. As a result, the caps are transferred onto the scratch pieces 58.

[0054] As shown in (b) of FIG. 7 and (a) and (b) of FIG. 8A, the scratch piece unit 60 is moved in the conveying direction of the conveyor 6 (in the positive direction of the X-axis). Subsequently, the array of the capping chucks 36 and the array of the caps 48 of the scratch pieces 58 of the scratch piece unit 60 are made parallel to each other.

[0055] Then, as shown in (c) of FIG. 7 and (a) and (b) of FIG. 8B, the scratch piece unit 60 is moved in the negative direction of the Y-axis, until the caps 48 on the scratch pieces 58 are just under the respective capping chucks 36. In this manner, the scratch piece unit 60 is moved to the setting position where the caps 48 are aligned with the capping chucks 36. Furthermore, the scratch piece unit 60 is moved in such a manner that its speed relative to the operation unit 18 becomes zero. In other words, the scratch piece unit 60 and the operation unit 18 are moved in the positive direction of the X-axis at the same speed.

[0056] As shown in (d) of FIG. 7 and (a) and (b) of FIG. 9A, the second servo motor 20 is rotated, and the capping chucks 36 are moved downward (in the negative direction of the Z-axis in (b) of FIG. 9A). Thereafter, the chuck portions 40 chuck the caps 48 on the scratch pieces 58.

[0057] As shown in (a) and (b) of FIG. 9B, the capping chucks 36 are moved upward (in the positive direction of the Z-axis in (b) of FIG. 9A). In other words, the caps 48 are separated from the scratch pieces 58.

[0058] As shown in (d) of FIG. 7 and (a) and (b) of FIG. 9C, the scratch piece unit 60 is moved from under the capping chucks 36 in the negative direction of the X-axis and the positive direction of the Y-axis. That is, the scratch piece unit 60 is returned to the original position shown in (a) of FIG. 7. At the time, the receptacles 8 are being linearly conveyed on the conveyor 6 in the region just under the capping chucks 36.

[0059] The motor 42 rotates the chuck portions 40 in the predetermined direction when the capping chucks 36 are being moved downward (in the negative direction of the Z-axis). The caps 48 are provided on the respective receptacles 8, with their tightness for the receptacles 8 being controlled in an optimal manner.

[0060] The cap portions 40 are opened, and the capping chucks 36 are separated from the capping chucks 36. The capping chucks 36 are moved upward (in the positive direction of the Z-axis). The first servo motor 16 is stopped to temporarily stop the operation unit 18. Thereafter, the first servo motor 16 is rotated in the reverse direction to move the operation unit 18 toward a predetermined upstream position on the conveyor 6 (in the negative direction of the X-axis).

[0061] When the operation unit 18 has come to the predetermined upstream position on the conveyor 6, the first servo motor 16 is stopped to temporarily stop the operation unit 18. At the time, the scratch piece unit 60 is disposed upstream of the terminating end of the cap transport passage. Then, the operation unit 18 is moved again in the conveying direction of the conveyor 6 (in the positive direction of the X-axis). The caps 48 are sequentially mounted on the scratch pieces 58, as shown in (a) of FIG. 7.

[0062] The above process is repeated to sequentially provide the caps 48 on the receptacles 8.

[0063] In the initial state of the above process, the moving speed of the scratch piece unit 60 as measured in the positive direction of the X-axis is set higher than that of the operation unit 18 as measured in the same direction, and the caps 48 are sequentially mounted from the cap transport passage 50 by scratching. The present invention should not be limited to this. For example, the scratch piece transport mechanism 52 may be moved in such a manner as to follow the operation unit 18.

[0064] The steps of the above process need not be executed one by one. In other words, a given step can be executed without waiting for its preceding step to

end. For example, the capping chucks 36 may cap a receptacle 8 when the scratch piece unit 60 is scratching another caps 48. If this is performed, the cappers 2 can be moved with high efficiency.

[0065] The caps 48 are transferred from the scratch piece unit 60 to the capping chucks 36. Then, the scratch piece transport mechanism 52 is actuated to move the scratch piece unit 60 from under the capping chucks 36. At the time, the caps 48 may be sensed to see if they are on the scratch pieces 58. If this sensing operation shows that the caps 48 remains on the scratch piece 58 (i.e., if a chucking error occurs), the entire capper 2 is brought to a halt.

[0066] The capping chucks 36 move upward after they receive the caps 48 from the scratch pieces 58 of the scratch piece unit 60. At the time, the caps 48 may be sensed to see if they are held on the scratch pieces 58. If they are not, a chucking error is determined, and the capper is brought to a halt. In this case, the chuck portions 40 may be associated with the cap transport passage 50 and scratch piece unit 60 so as to sense whether or not the caps 48 are arranged on the scratch pieces 58 of the scratch piece unit 60.

[0067] In the embodiment described above, the scratch unit 60 has three scratch pieces 58, but this number does not restrict the present invention. The scratch piece unit 60 may have only one scratch piece, two scratch pieces, four or more scratch pieces. Where four or more scratch pieces arranged on the scratch piece unit 60 are provided in an array, the moving distance of the operation unit 18 is set to be long. In addition, the scratch pieces 58 need not be arranged in a single array. They may be arranged in a number of arrays, such as two or three arrays. Likewise, the capping chucks 36 may be arranged in a number of arrays so as to cap a large number of receptacles 8 at a time. In this case, three conveyors 6 may be provided. Alternatively, a wide conveyor 6 in which three arrays of receptacles 8 are arranged may be provided.

[0068] In the embodiment described above, the ball screw 26 is used for vertically moving the capping chucks 36. The ball screw 26 may be replaced with a cylinder device, if so desired. Likewise, the first and second axially moving means 84 and 86 may employ cylinder devices in place of the ball screws 64 and 72. Conversely, each gripper 10 may employ a ball screw in place of the cylinder device 96.

[0069] In the above embodiment of the present invention, the scratch piece unit 60 is moved in the direction orthogonal to the conveying direction of the conveyor 6. In place of this structure, the capping chucks 36 may be moved in the direction orthogonal to the conveying direction of the conveyor 6. Where this alternative structure is employed, the chuck portions 40 do not move over the receptacles 8 when they are retreated, and it is therefore unlikely that foreign matter will fall into the receptacles 8.

[0070] The capping chucks 36 may be moved in the

direction orthogonal to the conveying direction of the conveyor 6, as described above. Such a structure is applicable not only to the capper 2 described above but also to another type of apparatus, such as a filling apparatus. In the case of application to the filling apparatus, nozzles are moved back and forth to obtain similar advantages.

[0071] In the capper 2 of the above embodiment, the receptacles 8 must be arranged on the conveyor 6 at regular intervals and moved. This, however, does not restrict the present invention. For example, the grippers 10 of the above embodiment may be designed to operate independently of one another and to sense the receptacles 8 before these receptacles 8 reach them. To be more specific, the operation unit 18 is moved in the conveying direction of the conveyor 6 in accordance with the arrangement of the receptacles 8, and the grippers 10 are individually opened or closed. With this structure, the receptacles 8 are held reliably even if they are shifted from their right positions, and reliable capping of the receptacles 8 is thus ensured. Since the receptacles 8 need not be accurately arranged, a means for doing so, such as an attachment chain, is not required.

[0072] In the embodiment of the present invention, the caps 48 are provided for the receptacles 8 by rotating the capping chucks 36 until the caps 48 are tightened on the receptacles 8. The capping method is not limited to such rotation and may be pushing in, for example. In this alternative capping method, the capping chucks 36 are not rotated but vertically moved by means of the second servo motor 20. By utilization of this vertical movement, the caps 48 are pushed in the receptacles 8.

[0073] To summarize the above, the following advantages can be pointed out with respect to the linear capper 2 of the embodiment.

[0074] When the receptacles 8 on the conveyor 6 are carried, a unit that includes movable parts is not located above them. With this structure, the receptacles 8 are not adversely affected by a dropping component, and the abraded particles from the operation unit 18 do not attach to, or enter the receptacles 8.

[0075] The scratch piece unit 60 is movable in a horizontal plane only. Since this structure leads to a simple mechanism, the capper 2 can be made of a small number of parts and manufactured at low cost.

[0076] Since the operation unit 18 and the scratch piece unit 60 are small, especially in light of the dimension measured in the conveying direction of the conveyor 6, an efficient operation is ensured. In addition, the capper 2 can be compact in size.

[0077] Furthermore, the weight of the scratch pieces 58 does not have adverse effects on the positions of the caps 48. The caps 48 can be reliably arranged at their intended positions.

[0078] The capping chucks 36 are vertically moved by means of the second servo motor 20. With this structure, the stroke of the chuck portions 40 can be controlled

arbitrarily, and the scratch piece unit 60 need not be moved vertically. In addition, the cap supply section and the cap transport passage may be simple in mechanism and can be manufactured at low cost.

Claims

1. A linear capper (2) **characterized by** comprising:

a conveyor (6) which sequentially conveys a plurality of receptacles (8) at a constant rate;
a cap transport passage (50) along which caps (48) for the receptacles are supplied;
a scratch piece unit (60) in which a plurality of scratch pieces (58) for receiving the caps (48) are arranged in a single plane such that one array or a number of parallel arrays are formed;
a scratch piece unit transport mechanism (52) which transports the scratch piece unit (60) between a cap-receiving position and a setting position in a substantially horizontal plane, the cap-receiving position being a position where the caps (48) are sequentially transferred from a terminating end of the cap transport passage (50) to the scratch pieces (58) of the scratch piece unit (60), and the setting position being a position where the scratch piece unit (60) is set above the conveyor (6);
a plurality of capping chucks (36) arranged in one or more arrays in a direction in which the receptacles (8) are fed, the capping chucks (36) chucking the caps (48) mounted on the scratch pieces (58) in a state where the scratch piece unit (60) is located at the setting position and above the conveyor (6); and
chuck driving means (90) for vertically driving the capping chucks (36), the chuck driving means (90) lowering the capping chucks (36) from a standby position, which is above the scratch piece unit (60), to a capping position where the receptacles (8) are capped, when the scratch piece unit (60) separates from the conveyor (6), the chuck driving means (90) capping the receptacles (48) while moving in such a manner as to follow the conveyor (6).

2. A linear capper according to claim 1, **characterized in that** said scratch piece unit transport mechanism (52) includes:

first axially moving means (84) comprising:

a first guide section (62) shaped as a rail;
a first slider (66) attached to the scratch piece unit (60) and being slidable along the first guide section (62); and
a first driving member (68) being slidable

on the first guide section (62) and transmitting power to the first slider (66); and

second axially moving means (86) comprising:

a second guide section (70) shaped as a rail and being orthogonal to the first guide section (62); a second slider (74) being slidable along the second guide section (70); an engagement member (78) attached to the second slider (74) and in engagement with a lower portion of the scratch piece unit (60); and a second driving member (76) which transmits power to the second slider (74) and thereby causes the second slider (74) to slide on the second guide section (70),

at least one of the first and second driving members (68, 76) being operated to slide at least one of the first and second sliders (66, 74) along the first and second guide sections (62, 70),

said engagement member (78) and said first slider (66) permitting the scratch piece unit (60) to move in a predetermined horizontal plane.

3. A linear capper according to claim 1, characterized in that said chuck driving means (90) includes:

a rotating member (20);
a driving force-converting member (26) which converts rotation of the rotating member (20) into linear movement; and
a capping head (34) provided for the driving force-converting member (36) and comprising the capping chucks (36),
said chuck driving means (90) vertically moving the capping chucks (36).

4. A capping method wherein a conveyor (6) sequentially conveys a plurality of receptacles (8) at a constant rate, caps (48) for the receptacles are first supplied along a cap transport passage (50) and then sequentially transferred from a terminating end of the cap transport passage (50) onto a scratch piece unit (60) in which a plurality of scratch pieces (58) are arranged in such a manner as to form one array or a number of arrays, the scratch piece unit (60) is moved to a position above the conveyor (6), and the caps (48) mounted on the scratch pieces (58) of the scratch piece unit (60) are chucked by capping chucks (36) and attached to the receptacles (8), for capping, said capping method characterized by comprising:

a step of moving the scratch piece unit (60) to a position below the capping chucks (36) in a

substantially horizontal plane until the caps (48) and the capping chucks (36) are substantially aligned;

a step of lowering the capping chucks (36) until the capping chucks (36) chuck the caps (48);
a step of moving the capping chucks (36) upward and thereafter moving the scratch piece unit (60) away from a position where the scratch piece unit (60) is below the capping chucks (36) and the caps (48) on the scratch piece unit (60) are aligned with the capping chucks (36);
a step of capping the receptacles (8) while moving the capping chucks (36) down; and
a step of opening the capping chucks (36), separating the capping chucks (36) from the caps (48), and moving the capping chucks (36) upward.

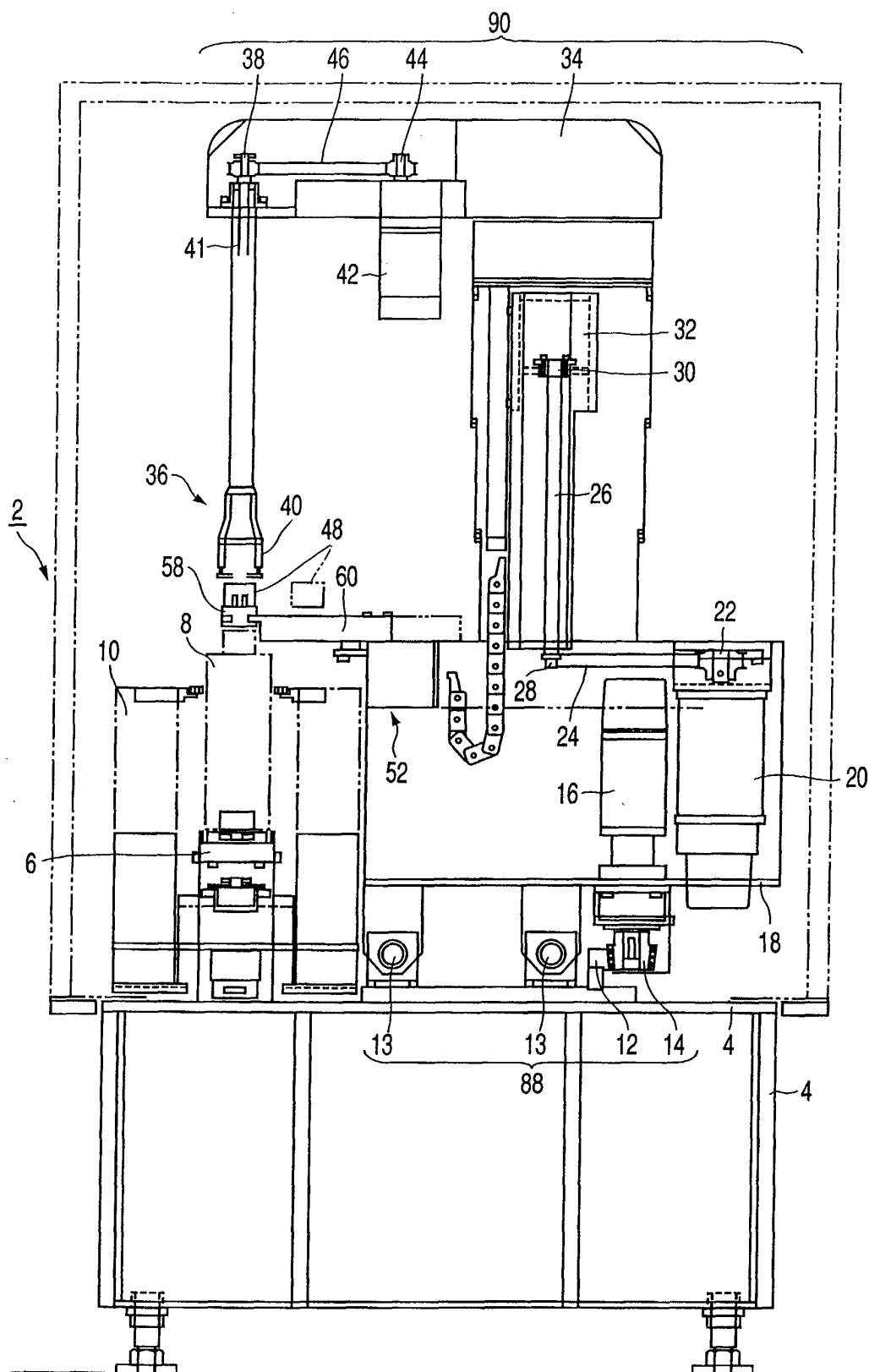
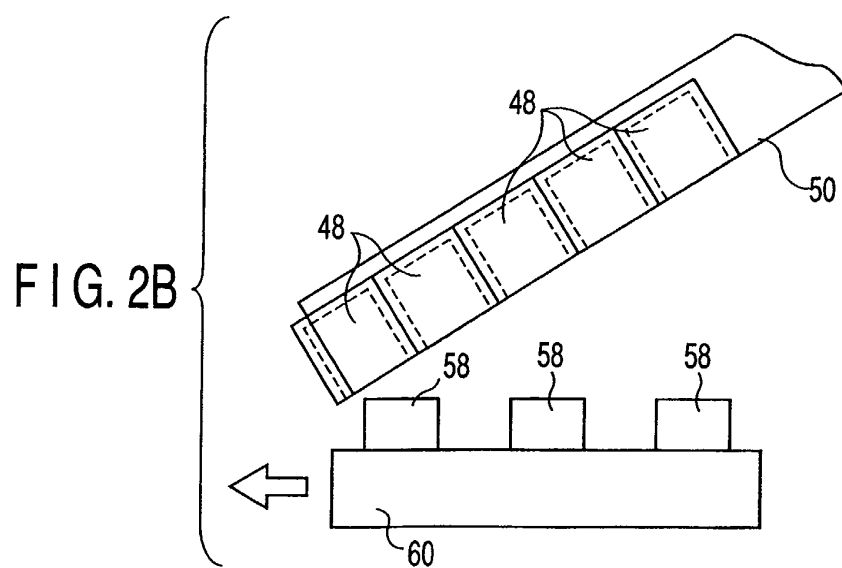
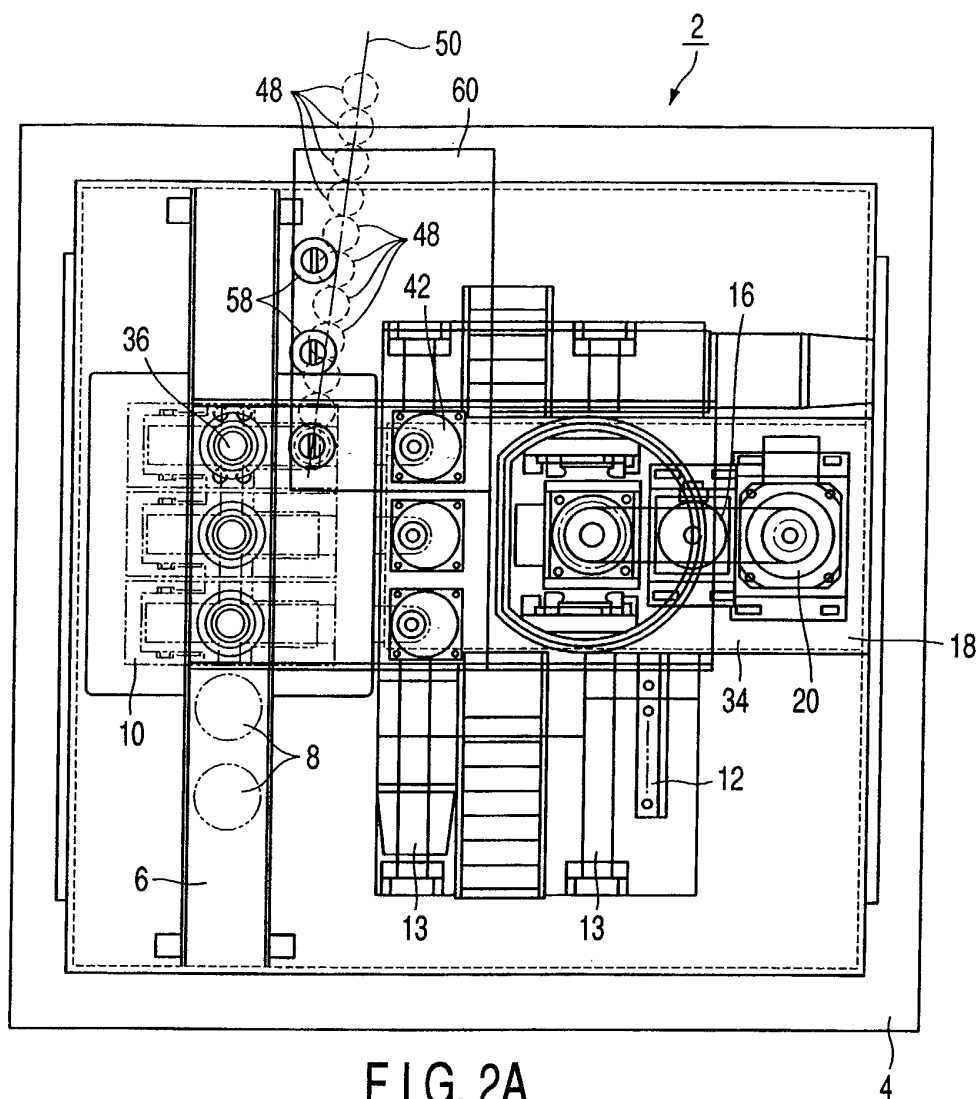
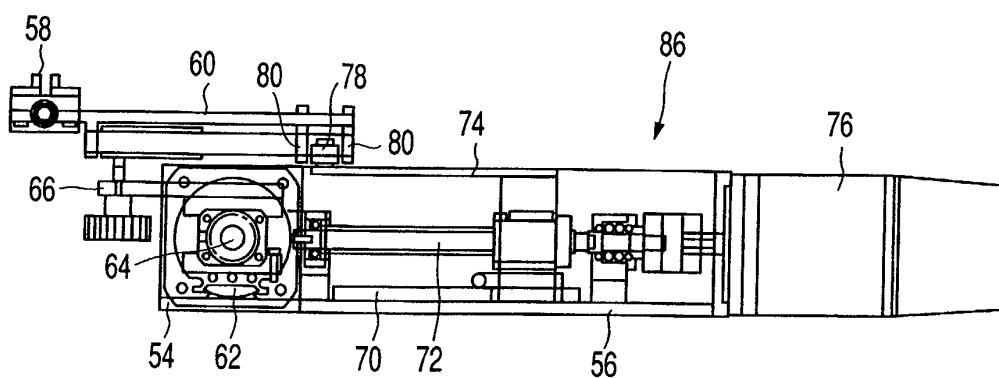
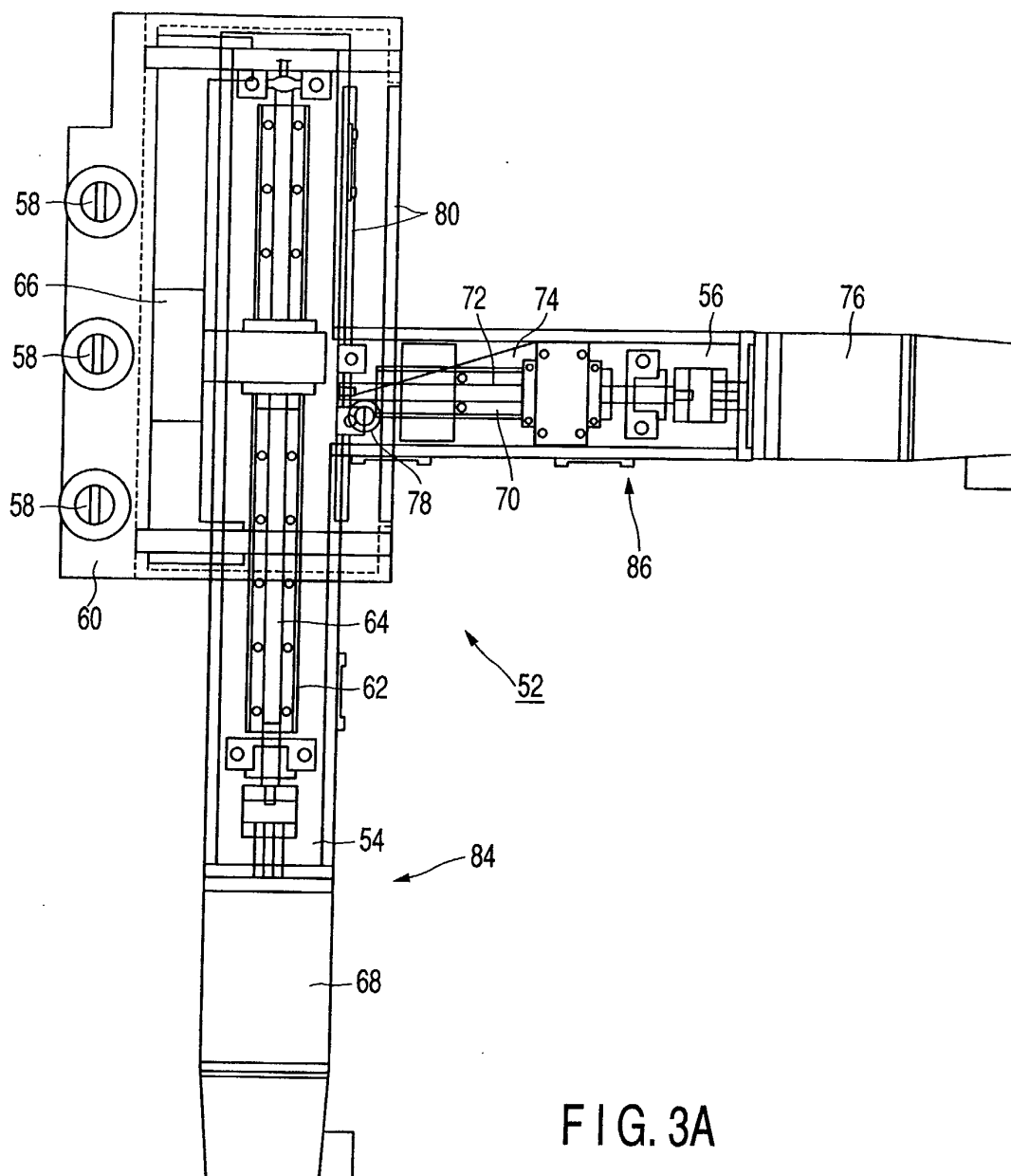


FIG. 1





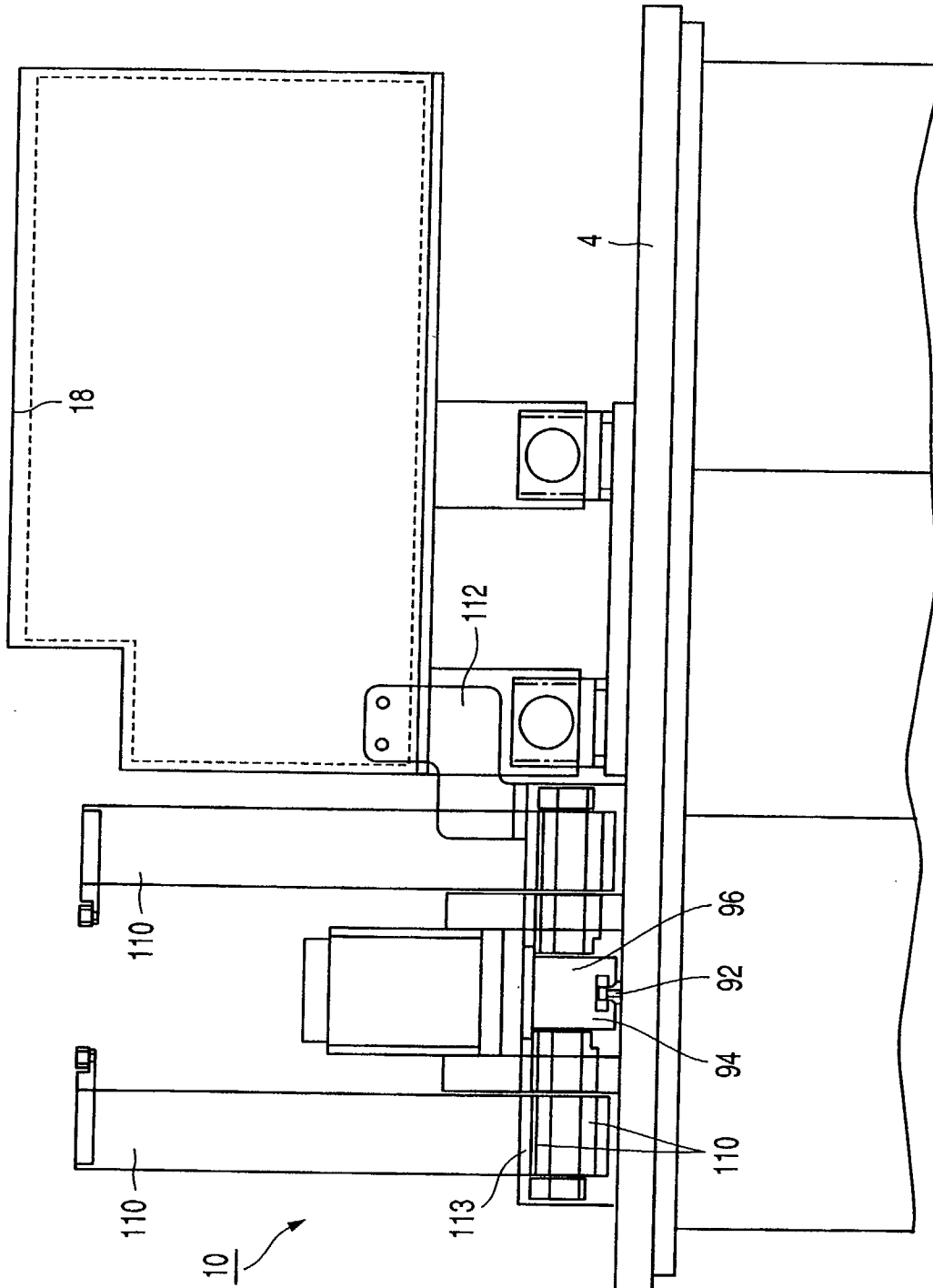


FIG. 4

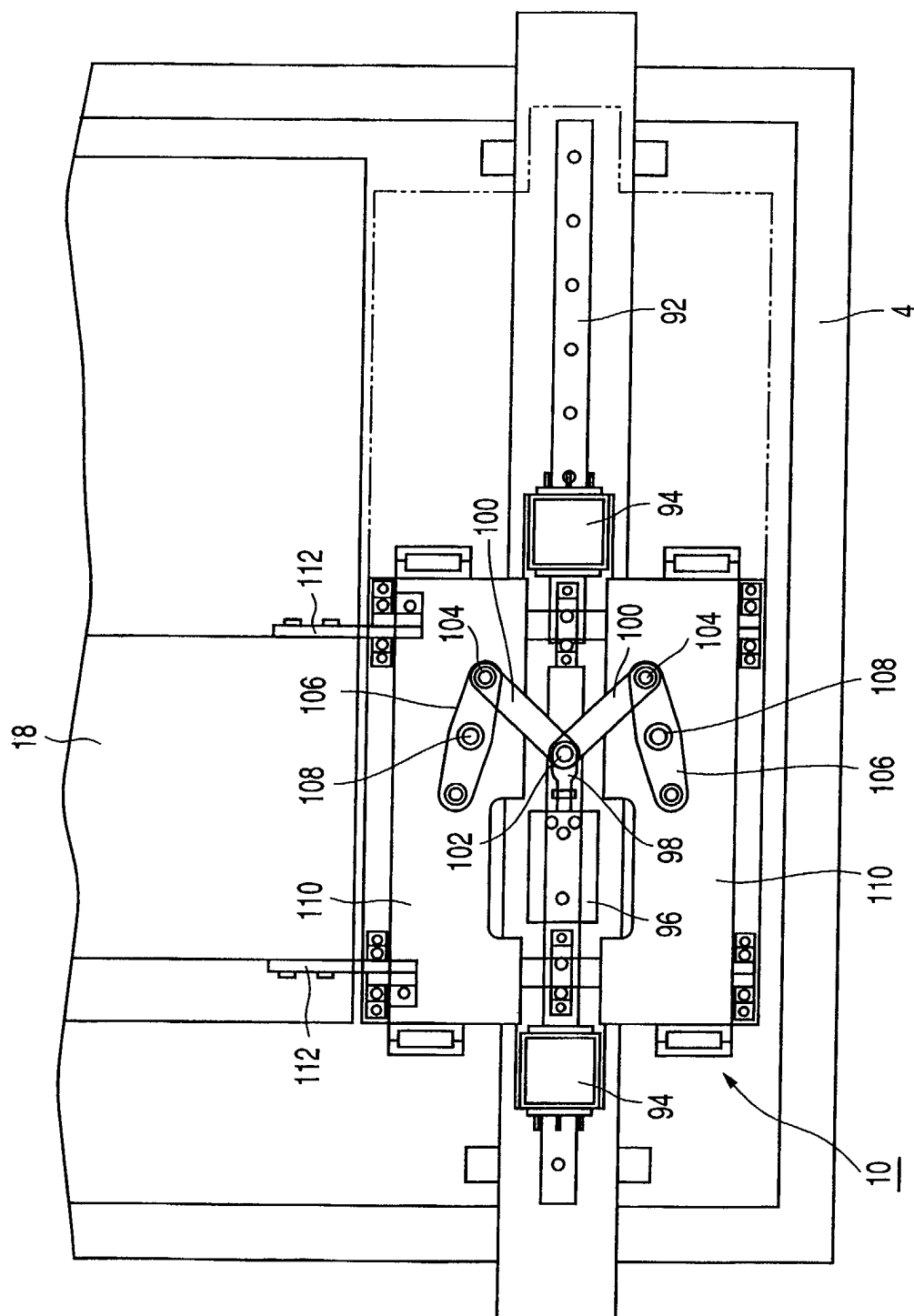
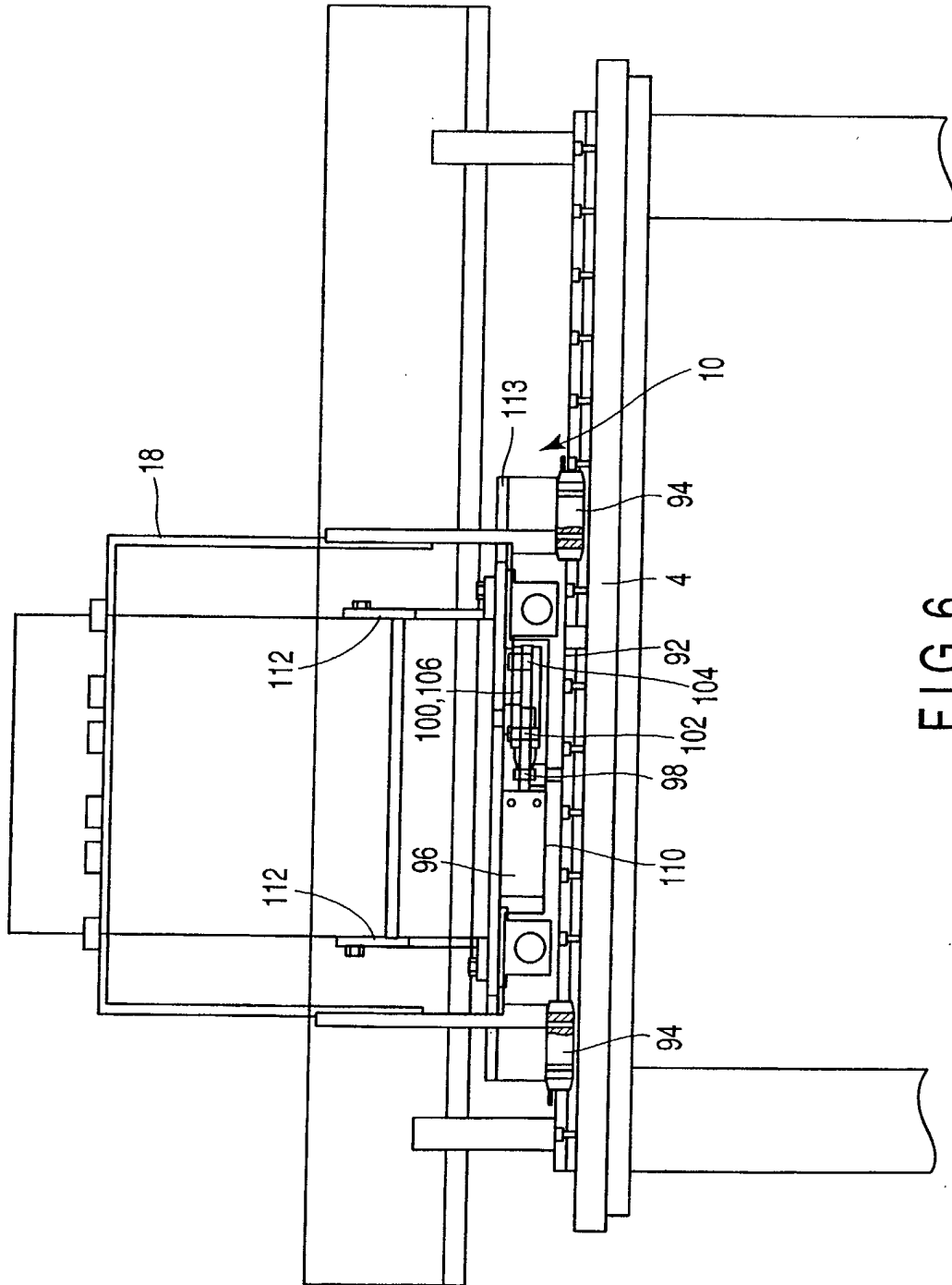


FIG. 5



F1G. 6

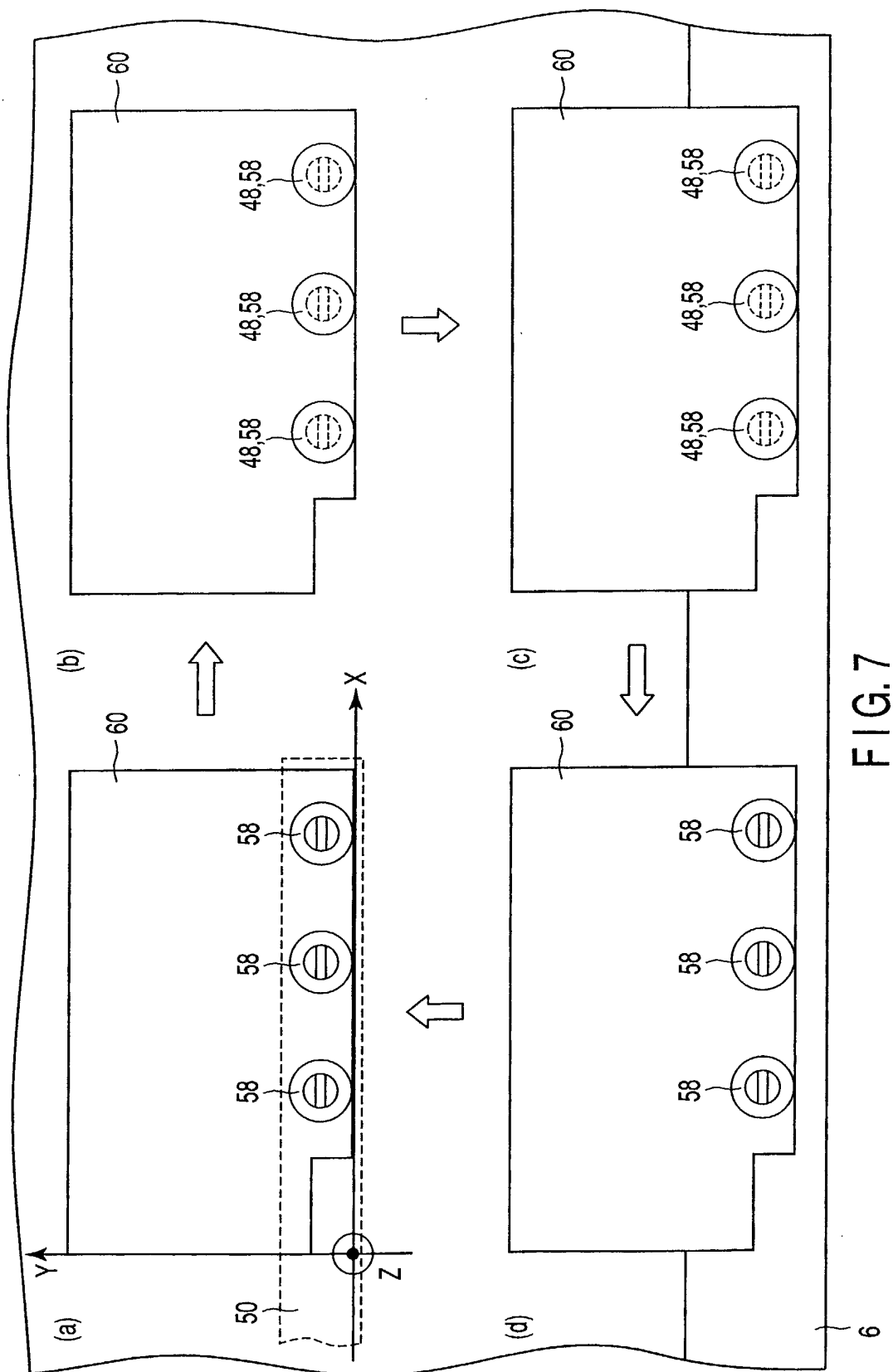


FIG. 7

FIG. 8A

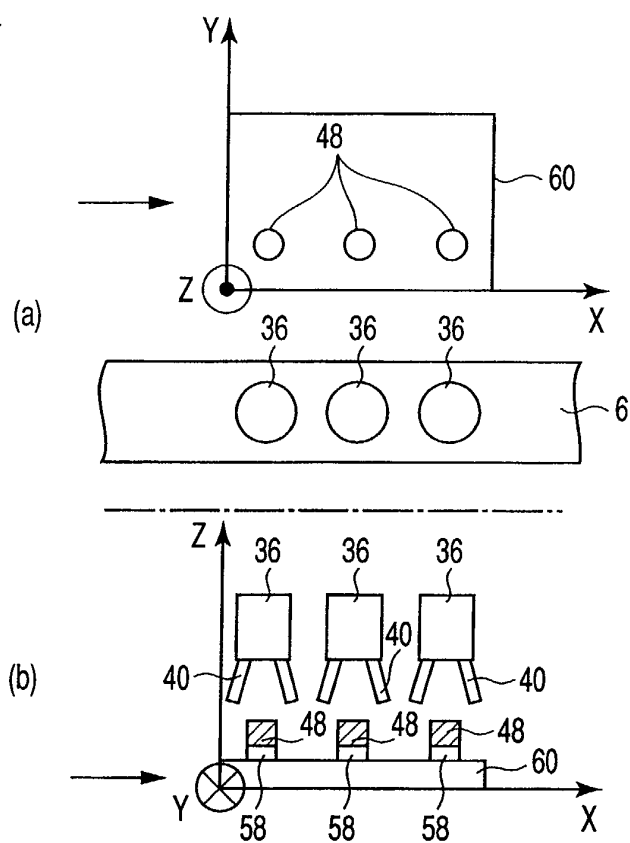


FIG. 8B

