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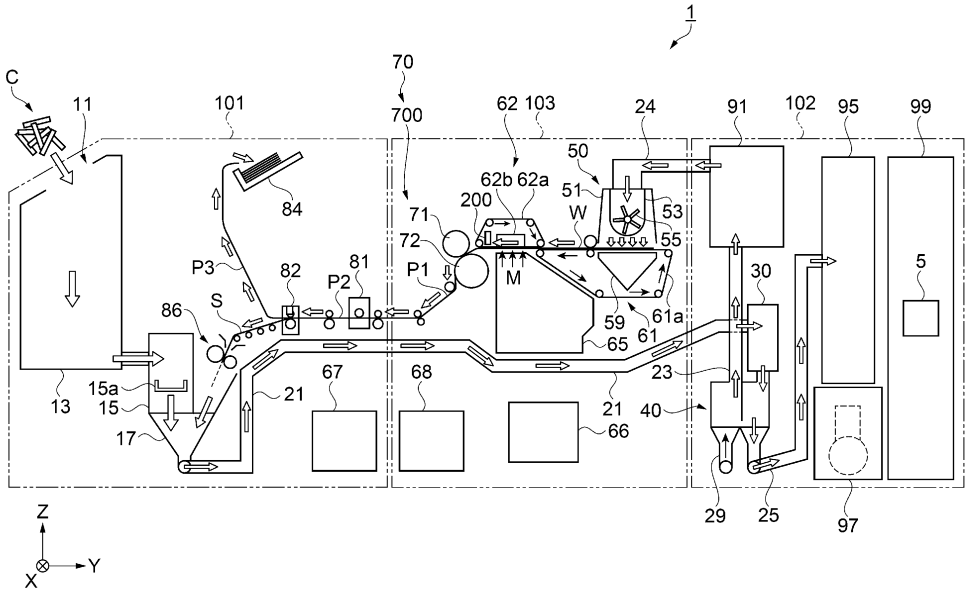
(54) SHEET MANUFACTURING APPARATUS

(57) A sheet manufacturing apparatus includes a defibrator that generates a defibrated material, a accumulating portion that forms a web by accumulating the defibrated material, and a sheet shaping portion that includes a first roller and a second roller, and forms a strip-shaped sheet by pressing the web. The sheet shaping portion includes a first roller retention unit at which the first roller is installed, a drive motor, a gear to which rotation of the drive motor is transmitted so as to rotate the second roller, a first transmission gear to which rotation of the gear is transmitted, a one-way clutch gear installed at the same rotating shaft as the first transmission gear, a gear to which rotation of the one-way clutch gear is transmitted, a cam installed coaxially with the gear, and a pin that is fixed to the first roller retention unit and performs positioning of the first roller retention unit by coming into contact with the cam. The first transmission gear includes an idling mechanism capable of running idle over a certain period.

FIG. 1



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Description

[0001] The present application is based on, and claims priority from JP Application Serial Number 2023-171148, filed October 2, 2023, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a sheet manufacturing apparatus.

2. Related Art

[0003] There have heretofore been known apparatuses for manufacturing sheets by using fibers obtained by defibrating used paper and the like in air. Such apparatuses include one configured to shape a sheet from a web containing fibers. For example, JP-A-2014-208923 discloses a sheet manufacturing apparatus that includes pairs for rollers for pressing and the like in order to shape web into a sheet.

[0004] However, the apparatus disclosed in JP-A-2014-208923 may cause a problem of the apparatus in a case where a tip end of the web has a small thickness. Specifically, there is a problem of a difficulty in controlling the thickness at the tip end of the web in a process of forming the web by accumulating a material such as fibers in the air. If the thickness of the tip end of the web becomes small, the web may occasionally adheres to a heating roller. Meanwhile, since a thickness of a tip end of a sheet shaped from the web is also reduced, the sheet is prone to buckling due to a shortage in mechanical strength at the tip end thereof. In other words, the tip end of the sheet may be caught on a component such as a transportation roller in a transportation path for the sheets and may possibly cause a paper jam. The following device has been accomplished in order to solve the aforementioned problems without incurring an increase in size of an apparatus or an increase in the number of components.

SUMMARY

[0005] A sheet manufacturing apparatus includes: a defibrator that defibrates a material containing a fiber and generates a defibrated material; a accumulating portion that forms a web by accumulating the defibrated material; and a sheet shaping portion that includes a first roller and a second roller, and forms a sheet by pressing the web, the sheet shaping portion includes a first roller retention unit at which the first roller is installed, a drive motor that is configured to be rotated in a forward direction and a reverse direction, a second roller gear that receives transmission of rotation of the drive motor and rotates the second roller, a first transmission gear that receives transmission of rotation of the second roller gear, a one-way clutch gear installed at a rotating shaft common to the first transmission gear, a cam gear that receives transmission of rotation of the one-way clutch gear, a cam installed coaxially with the cam gear, and a pin that is fixed to the first roller retention unit and performs positioning of the first roller retention unit by coming into contact with the cam, and the first transmission gear includes an idling mechanism configured to run idle over a certain period.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a schematic diagram illustrating a configuration of a sheet manufacturing apparatus according to an embodiment.
FIG. 2 is a flowchart illustrating a web folding operation.
FIG. 3 is a schematic diagram illustrating a web folding method.
FIG. 4 is another schematic diagram illustrating the web folding method.
FIG. 5 is another schematic diagram illustrating the web folding method.
FIG. 6 is another schematic diagram illustrating the web folding method.
FIG. 7 is a perspective view illustrating a configuration of a sheet shaping portion.
FIG. 8 is a side view illustrating the configuration of the sheet shaping portion.
FIG. 9 is a perspective view illustrating a layout of a first roller retention unit and a first roller.
FIG. 10 is a perspective cross-sectional view illustrating a layout of a first transmission gear, a one-way clutch gear, and the like.
FIG. 11 is a cross-sectional perspective view illustrating a layout of a cam gear, a cam, and a cam connecting shaft.
FIG. 12 is a perspective view illustrating a configuration of an idling mechanism of the first transmission gear.
FIG. 13 is a schematic diagram illustrating an operation of the idling mechanism.
FIG. 14 is a schematic diagram illustrating another operation of the idling mechanism.
FIG. 15 is a side view illustrating a paused state of the sheet shaping portion.
FIG. 16 is a side view illustrating an operation preparatory action of the sheet shaping portion.
FIG. 17 is another side view illustrating the operation preparatory action of the sheet shaping portion.
FIG. 18 is a side view illustrating a web bending action of the sheet shaping portion.
FIG. 19 is a side view illustrating a web folding action and a sheet forming action of the sheet shaping portion.

FIG. 20 is a side view illustrating a pre-pause action of the sheet shaping portion.

FIG. 21 is another side view illustrating the pre-pause action of the sheet shaping portion.

FIG. 22 is another side view illustrating the pre-pause action of the sheet shaping portion.

DESCRIPTION OF EMBODIMENTS

[0007] The following embodiment exemplifies a sheet manufacturing apparatus 1 of a dry type, which recycles used paper and the like into sheets, as a sheet manufacturing apparatus of the present disclosure. Now, the sheet manufacturing apparatus 1 will be described below with reference to the drawings. Note that the sheet manufacturing apparatus of the present disclosure is not limited to be of the dry type but may also be of a wet type. In the present disclosure, the dry type is a mode implemented in air such as atmosphere without being implemented in a liquid.

[0008] In the respective drawings cited below, xyz axes are provided as coordinate axes that are orthogonal to one another. A direction indicated with each arrow will be defined as + direction while a direction opposite to the + direction will be defined as - direction. The z axis is a virtual axis extending along a vertical direction. Here, +z direction is deemed to be upward while -z direction is deemed to be downward. The -z direction is equivalent to a direction of action of the gravity. Meanwhile, in the sheet manufacturing apparatus 1, a destination in a direction of transportation of raw materials, web, sheets, and the like may be referred to downstream while the other side to head back in the direction of transportation may be referred to upstream in some cases. Sizes of respective constituents may be different from actuality for the convenience of illustration.

[0009] In the present specification, a first direction represents a counterclockwise rotational direction in side view from the -x direction. Meanwhile, a second direction represents an opposite direction to the first direction, which is a clockwise rotational direction in side view from the -x direction.

1. Sheet manufacturing apparatus

[0010] As illustrated in FIG. 1, the sheet manufacturing apparatus 1 according to the present embodiment includes a first unit group 101, a second unit group 102, and a third unit group 103. The first unit group 101, the second unit group 102, and the third unit group 103 are supported by a not-illustrated frame. In FIG. 1, directions of movement of used paper C, sheets P3, slit pieces S, unnecessary listing, and the like are indicated with open arrows.

[0011] The sheet manufacturing apparatus 1 manufactures the sheet P3 from the used paper C being a material that contains fibers. In the sheet manufacturing apparatus 1, the first unit group 101, the third unit group 103, and the second unit group 102 are arranged from the -y direction to the +y direction in side view from the -x direction.

[0012] The used paper C is transported from the first unit group 101 to the second unit group 102 through a pipe 21 that traverses the inside of the third unit group 103. Then, the used paper C undergoes defibration and the like in the second unit group 102 so as to be converted into fibers, which are then formed into a mixture that contains a binding agent and the like. The mixture is transported to the third unit group 103 through a pipe 24. The mixture is formed into web W by the third unit group 103 and then shaped into a strip-shaped sheet P1. The strip-shaped sheet P1 is cut into the sheets P3 in the first unit group 101.

[0013] The first unit group 101 includes a buffer tank 13, a volumetric feeder portion 15, a confluent portion 17, and the pipe 21. In the first unit group 101, these constituents are arranged in the enumerated order from the upstream to the downstream. Moreover, the first unit group 101 also includes a first cutting portion 81, a second cutting portion 82, a tray 84, and a shredding portion 86. The first cutting portion 81 and the second cutting portion 82 cut the strip-shaped sheet P1 into the sheets P3 in a predetermined shape. Furthermore, the first unit group 101 includes a water feeding portion 67. The water feeding portion 67 is a water storage tank. The water feeding portion 67 feeds water for humidification to each of a first humidifying portion 65 and a second humidifying portion 66 to be described later by using not-illustrated water feed pipes.

[0014] The used paper C is put from a raw material input slot 11 into the buffer tank 13. The used paper C is a scrap of shredded used paper that contains fibers such as cellulose, for example. Humidified air is supplied from the second humidifying portion 66 provided to the third unit group 103 into the buffer tank 13.

[0015] The used paper C to be defibrated is temporarily stored in the buffer tank 13 and is then transported to the volumetric feeder portion 15 in accordance with an operation of the sheet manufacturing apparatus 1. The sheet manufacturing apparatus 1 may include a shredder located upstream of the buffer tank 13 and configured to shred the used paper C and the like.

[0016] The volumetric feeder portion 15 includes a measure 15a and a not-illustrated feeding mechanism. The measure 15a measures the mass of the used paper C. The feeding mechanism feeds the used paper C measured with the measure 15a to the confluent portion 17 located downstream. In other words, the volumetric feeder portion 15 measures the used paper C into each predetermined mass with the measure 15a and feeds the measured used paper C to the confluent portion 17 located downstream by using the feeding mechanism.

[0017] The measure 15a can adopt a measuring mechanism of a digital type or an analog type. To be more precise, the measure 15a may adopt a physical sensor such as a load cell, a spring scale, a balance, and the like.

In the present embodiment, a load cell is used as the measure 15a. The predetermined mass of the used paper C to be measured with the measure 15a ranges from about several grams to several tens of grams, for example.

[0018] The feeding mechanism can adopt publicly known techniques such as a vibration feeder. The feeding mechanism may be incorporated in the measure 15a.

[0019] The measurement and feeding operations of the used paper C by the volumetric feeder portion 15 are batch processes. In other words, the feeding of the used paper C from the volumetric feeder portion 15 to the confluent portion 17 is intermittently carried out. The volumetric feeder portion 15 may include two or more measures 15a, and may improve measurement efficiency by operating the measures 15a in a time-shifted fashion.

[0020] In the confluent portion 17, the shredded slit pieces S supplied from the shredding portion 86 is put into and mixed with the used paper C fed from the volumetric feeder portion 15. The slit pieces S and the shredding portion 86 will be described later. The used paper C mixed with the above-mentioned shredded pieces flows from the confluent portion 17 into the pipe 21.

[0021] The pipe 21 transports the used paper C from the first unit group 101 to the second unit group 102 by using an airflow generated by a not-illustrated blower.

[0022] The second unit group 102 includes a defibrator 30 being a dry-type defibrator, a separating portion 40, a pipe 23, a mixing portion 91, and the pipe 24. In the second unit group 102, these constituents are arranged in the enumerated order from the upstream to the downstream. Moreover, the second unit group 102 also includes a collecting portion 95, a compressor 97, a power source portion 99, a pipe 25 that is connected to the separating portion 40, and an airflow pipe 29.

[0023] The used paper C transported in the pipe 21 flows into the defibrator 30. The defibrator 30 defibrates the used paper C being a material containing the fibers in a dry mode, thus generating a defibrated material containing the fibers. A publicly known defibration mechanism is applicable to the defibrator 30. In the present embodiment, a defibration mechanism provided with rotary blades is used as the defibrator 30. The defibration mechanism is configured to generate the fibers by shredding and defibrating the used paper C with the rotary blades.

[0024] The used paper C is formed into the defibrated material containing the fibers by disentangling the entangled fibers contained in the used paper C by using the defibrator 30, and the defibrated material is transported to the separating portion 40.

[0025] The separating portion 40 separates the defibrated fibers. Specifically, the separating portion 40 removes certain components contained in the fibers, which are unnecessary for manufacturing the sheets P3. That is to say, the separating portion 40 separates relatively long fibers from relatively short fibers. The relatively short fibers may cause a degradation in strength of the sheets P3, and are therefore sifted and eliminated by the separating portion 40. Moreover, the separating portion 40 also eliminates impurities such as coloring materials and additives contained in the used paper C.

[0026] A publicly known separation mechanism is applicable to the separating portion 40. In the present embodiment, a disk-type separation mechanism provided with a separation filter is used as the separating portion 40. The separation mechanism is configured to sift and separate the relatively short fibers that pass through the separation filter from the relatively long fibers that do not pass through the separation filter. The relatively long fibers are used as the defibrated material, which is the material of the web W.

[0027] The humidified air is supplied from the second humidifying portion 66 of the third unit group 103 into the separating portion 40.

[0028] The defibrated fibers are deprived of the relatively short fibers and the like by the separating portion 40. Then, the defibrated fibers are transported with an airflow, which is generated by a not-illustrated blower disposed at a tip end of the airflow pipe 29, to the mixing portion 91 through the pipe 23. Unwanted substances such as the relatively short fibers and the impurities are discharged to the collecting portion 95 through the pipe 25.

[0029] The mixing portion 91 mixes the defibrated material with the binding agent and the like in the air, thereby forming the mixture. Although illustration is omitted, the mixing portion 91 includes a flow path to transport the defibrated material, a fan, a hopper, a supply pipe, and a valve.

[0030] The hopper communicates with the flow path for the defibrated material through the supply pipe. The valve is provided to the supply valve located between the hopper and the flow path. The hopper supplies the binding agent such as starch into the flow path. The valve adjusts a mass of the binding agent to be supplied from the hopper to the flow path. In this way, a mixture ratio of the fibers and the binding agent is adjusted.

[0031] In addition to the aforementioned structure for supplying the binding agent, the mixing portion 91 may include similar structured for supplying coloring agents, additives, and the like.

[0032] The fan in the mixing portion 91 generates an airflow so as to transport the defibrated material containing the fibers to the downstream and to mix the defibrated material with the binding agent and the like in the air at the same time, thus forming the mixture. The mixture flows from the mixing portion 91 into the pipe 24.

[0033] The collecting portion 95 includes a not-illustrated filter. The filter is configured to filter the unwanted substances such as the relatively short fibers transported in the pipe 25 by the airflow.

[0034] The compressor 97 generates compressed air. The above-mentioned filter may cause clogging of fine particles and the like among the unwanted substances.

The compressed air generated by the compressor 97 is caused to blow against the filter, so that the compressed air can blow the adhering particles away and clean the filter.

[0035] The power source portion 99 includes a not-illustrated power supply device that supplies electric power to the sheet manufacturing apparatus 1, and a control unit 5. The power source portion 99 distributes the electric power supplied from outside to the respective structures in the sheet manufacturing apparatus 1.

[0036] Although illustration is omitted, the control unit 5 includes a central processing unit (CPU), and a storage unit that contains a random access memory (RAM), a read only memory (ROM), and so forth. Various programs for controlling the sheet manufacturing apparatus 1 are stored in the storage unit. The control unit 5 may include dedicated hardware (an application specific integrated circuit: ASIC) for executing at least part of various processing. Specifically, the control unit 5 may be constructed as a circuit that includes one or more processors to be operated in accordance with computer programs (software), one or more dedicated hardware circuits such as the ASIC, or a combination of these constituents.

[0037] The processor includes the CPU, and a memory such as the RAM and the ROM. The memory stores program codes or instructions configured to cause the CPU to execute the processing. The memory, namely, a computer-readable medium includes any media accessible to a general-purpose or special-purpose computer.

[0038] The control unit 5 is electrically coupled to respective structures in the sheet manufacturing apparatus 1 including a second transporting portion 62, an air injecting portion 200, and a sheet shaping portion 70, and integrally controls operations of these structures. In particular, the control unit 5 also governs control related to folding of the web W to be described later.

[0039] The third unit group 103 accumulates and compresses the mixture containing the fibers, thereby shaping the mixture into the strip-shaped sheet P1 which is recycled paper. The third unit group 103 includes an accumulating portion 50, a first transporting portion 61, the second transporting portion 62, the first humidifying portion 65, the air injecting portion 200, the second humidifying portion 66, a draining portion 68, and the sheet shaping portion 70. Note that the second transporting portion 62 is an example of a web transporting portion of the present disclosure.

[0040] In the third unit group 103, the accumulating portion 50, the first transporting portion 61, the second transporting portion 62, the first humidifying portion 65, and the sheet shaping portion 70 are arranged in the enumerated order from the upstream to the downstream. The air injecting portion 200 is located inside the second transporting portion 62 and is disposed at a downstream end portion of a transportation path for the web W in the second transporting portion 62. The second humidifying portion 66 is disposed below the first humidifying portion 65.

[0041] The accumulating portion 50 forms the web W by accumulating the mixture generated from the defibrated material while using an air flow and a gravitational force. The accumulating portion 50 includes a drum member 53, a vane member 55 installed in the drum member 53, a housing 51 to house the drum member 53, and a suctioning portion 59. The mixture is taken from the pipe 24 into the drum member 53.

[0042] The first transporting portion 61 is disposed below the accumulating portion 50. The first transporting portion 61 includes a mesh belt 61a and five non-illustrated stretch rollers for stretching the mesh belt 61a. The suctioning portion 59 is opposed to the drum member 53 in the direction along the z axis while interposing the mesh belt 61a therebetween.

[0043] The vane member 55 is located inside the drum member 53 and is rotationally driven by a not-illustrated motor. The drum member 53 is a sieve having a shape of a semicircular column. A mesh having a sieve function is provided on a side surface of the drum member 53 which is directed downward. The drum member 53 causes particles of the fibers and the mixture smaller than a size of mesh openings of the sieve to pass through the mesh from inside to outside.

[0044] The mixture is agitated by the rotating vane member 55 inside the drum member 53 and is discharged to outside of the drum member 53. The humidified air is supplied from the second humidifying portion 66 into the drum member 53.

[0045] The suctioning portion 59 is disposed below the drum member 53. The suctioning portion 59 suctions the air inside the housing 51 through pores provided to the mesh belt 61a. Thus, an airflow that accumulates the mixture on the mesh belt 61a is generated. The pores in the mesh belt 61a cause the air to pass therethrough but hardly causes the fibers, the binding agent, and the like included in the mixture to pass therethrough. Accordingly, the mixture discharged to the outside of the drum member 53 is suctioned downward together with the air. The suctioning portion 59 is a publicly known suctioning device such as a suctioning fan.

[0046] The mixture is dispersed in the air inside the housing 51 and is accumulated on an upper surface of the mesh belt 61a by the gravitational force and the airflow generated by the suctioning portion 59. Hence, the mixture turns into the web W.

[0047] The mesh belt 61a is an endless belt that is stretched around the five stretch rollers. The mesh belt 61a is rotated counterclockwise in FIG. 1 by rotation of the stretch rollers. In this way, the mixture is continuously accumulated on the mesh belt 61a and the web W is thus formed. The web W contains relatively a lot of air and is softly puffed. The first transporting portion 61 transports the generated web W downstream by the rotation of the mesh belt 61a.

[0048] The second transporting portion 62 transports the web W at the downstream of the first transporting portion 61 and instead of the first transporting portion 61.

The second transporting portion 62 peels the web W off the upper surface of the mesh belt 61a, and transports the web W toward the sheet shaping portion 70. The second transporting portion 62 is located above the transportation path for the web W and is disposed slightly on an upstream side relative to a point of origin on a return side of the mesh belt 61a. A portion in the +y direction of the second transporting portion 62 partially overlaps a portion in the -y direction of the mesh belt 61a in terms of the vertical direction.

[0049] The second transporting portion 62 includes a transporting belt 62a, four non-illustrated stretch rollers, and a suctioning portion 62b. The transporting belt 62a is provided with pores that allows the air to pass therethrough. The transporting belt 62a is stretched around the four stretch rollers and is rotated clockwise in FIG. 1 by rotation of the stretch rollers.

[0050] The suctioning portion 62b is located on the transportation path for the web W by the second transporting portion 62 and is disposed above the transporting belt 62a. The suctioning portion 62b suctions the air located below upward through the pores provided to the transporting belt 62a. Thus, one surface being an upper surface of the web W is suctioned toward a lower surface of the transporting belt 62a. By rotating the transporting belt 62a in this state, the web W is suctioned to the transporting belt 62a and transported downstream. In other words, the transporting belt 62a comes into contact with the one surface of the web W and transports the web W. The suctioning portion 62b is a publicly known suctioning device such as a suctioning fan.

[0051] The first humidifying portion 65 humidifies the web W containing the fibers accumulated by the accumulating portion 50 of the third unit group 103. Specifically, the first humidifying portion 65 is a mist-type humidifier configured to supply mist M from below to the web W transported by the second transporting portion 62, thereby humidifying the web W. The first humidifying portion 65 is disposed below the second transporting portion 62 and is opposed to the web W, which is transported by the second transporting portion 62, in the direction along the z axis. A publicly known humidification device such as an ultrasonic humidifier is applicable to the first humidifying portion 65.

[0052] Humidification of the web W with the mist M facilitates a function of the binding agent included in the web W, thereby increasing the strength of the sheets P3. Meanwhile, since the web W is humidified from below, drips originating from the mist M are kept from dropping on the web W. Moreover, since the web W is humidified from an opposite side of the one surface of the web W that is in contact with the transporting belt 62a, the web W is less likely to adhere to the transporting belt 62a. The second transporting portion 62 transports the web W toward the sheet shaping portion 70.

[0053] The air injecting portion 200 is located in the second transporting portion 62 and disposed downstream of the suctioning portion 62b. Although illustration is omitted, the air injecting portion 200 includes a pressurized air tank and an injection nozzle. The pressurized air tank supplies pressurized air to the injection nozzle. The air injecting portion 200 injects the pressurized air downward from the injection nozzle to the web W. The pressurized air is supplied from a not-illustrated compressor for the air injecting portion 200 and is stored in the pressurized air tank, for example.

[0054] The injection nozzle is an elongate opening that extends in a direction along the x axis. The injection nozzle is opposed to the web W transported by the transporting belt 62a in a direction along the z axis. The pressurized air injected from the air injecting portion 200 passes through the transporting belt 62a and hits the one surface of the web W suctioned to the lower surface of the transporting belt 62a. In this instance, a length of the injection nozzle is larger than a length of the web W in terms of the direction along the x axis. Accordingly, the pressurized air injected from the injection nozzle is sprayed on the entire width region of the web W.

[0055] In this way, the web W is peeled off the transporting belt 62a. The injection of the pressurized air by the air injecting portion 200 is carried out when a tip end on the downstream side of the web W reaches a region opposed to the air injecting portion 200. Then, after the aforementioned tip end of the web W is peeled off the transporting belt 62a, an operation to bend the tip end of the web W and an operation to fold the tip end of the web W are carried out. Thereafter, the web W is delivered from the second transporting portion 62 to the sheet shaping portion 70. Details of the bending and the folding operations of the web W will be described later.

[0056] The sheet shaping portion 70 includes a first roller 71 and a second roller 72. The first roller 71 and the second roller 72 collectively constitute a pressing roller pair 700. The sheet shaping portion 70 presses the web W between the first roller 71 and the second roller 72, thereby forming the strip-shaped sheet P1 from the web W.

[0057] The first roller 71 and the second roller 72 form the pair and each of the rollers is a member having a substantially columnar shape. A rotating shaft of the first roller 71 and a rotating shaft of the second roller 72 are arranged along the x axis. With respect to the transportation path for the web W, the first roller 71 is disposed almost above while the second roller 72 is disposed almost below. The first roller 71 and the second roller 72 come close to each other during the formation of the strip-shaped sheet P1 from the web W, and are rotated in such a way as to apply loads to the web W.

[0058] In the direction along the x axis, a length of the first roller 71 and a length of the second roller 72 are larger than the length of the web W, or in other words, the width of the web W. Accordingly, the web W is securely caught between the first roller 71 and the second roller 72.

[0059] A diameter of the first roller 71 is smaller than a diameter of the second roller 72. For example, the diameter of the first roller 71 is equal to or above 80 mm and

equal to or below 110 mm, and the diameter of the second roller 72 is equal to or above 110 mm and equal to or below 150 mm.

[0060] The first roller 71 includes a cored bar, an intermediate layer, and a superficial layer, for example. A hollow structure formed from aluminum, iron, stainless steel, and the like can be cited as an example of the cored bar. The intermediate layer covers the cored bar and is covered by the superficial layer. In other words, the intermediate layer is interposed between the cored bar and the superficial layer.

[0061] An elastic body such as silicone rubber and urethane rubber can be cited as an example of a material of the intermediate layer. Hardness of the aforementioned elastic body is preferably equal to or above 30 and equal to or below 70, or more preferably equal to or above 40 and equal to or below 60 in terms of a measurement value with an Asker C hardness scale. A thickness of the intermediate layer is preferably equal to or above 1 mm and equal to or below 10 mm, or more preferably equal to or above 1 mm and equal to or below 5 mm.

[0062] A fluorine-containing resin such as polytetrafluoroethylene (PTFE), tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer (PFA), tetrafluoroethylene-hexafluoropropylene copolymer (FEP), and tetrafluoroethylene-ethylene copolymer (ETFE) can be cited as an example of a material of the superficial layer.

[0063] When the first roller 71 adopts the above-described configuration, releasability of the first roller 71 with respect to the web W is improved. In the meantime, this configuration suppresses wear and damage of the intermediate layer.

[0064] The second roller 72 includes a cored bar and a superficial layer that covers the cored bar, for example. A hollow structure formed from aluminum, iron, stainless steel, and the like can be cited as an example of the cored bar. A fluorine-containing resin such as polytetrafluoroethylene (PTFE), tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer (PFA), tetrafluoroethylene-hexafluoropropylene copolymer (FEP), and tetrafluoroethylene-ethylene copolymer (ETFE), silicone resin, and the like can be cited as an example of a material of the superficial layer. In this way, releasability of the second roller 72 with respect to the web W is improved. In the meantime, this configuration suppresses wear and damage of the cored bar.

[0065] The web W is pressed in the course of passage between the first roller 71 and the second roller 72. A pressure from the first roller 71 and the second roller 72 to the web W is preferably equal to or above 0.1 MPa and equal to or below 15.0 MPa, more preferably equal to or above 0.2 MPa and equal to or below 10.0 MPa, or even more preferably equal to or above 0.4 MPa and equal to or below 8.0 MPa. Thus, deterioration of the fibers in the web W is suppressed.

[0066] The second roller 72 has an electric heater built-in and has a function to increase the temperature on a surface of the roller. It is preferable to provide the first roller 71 with a function to increase the temperature on a surface of the roller with an electric heater as with the second roller 72.

[0067] A surface temperature of the second roller 72, that is to say, a temperature of the superficial layer of the second roller 72 that comes into contact with the web W is preferably set equal to or above 100°C and equal to or below 130°C. A surface temperature of the first roller 71, that is to say, a temperature of the superficial layer of the first roller 71 that comes into contact with the web W is preferably set equal to or above 80°C and equal to or below 100°C.

[0068] The surface of the second roller 72 has relatively fine asperities. The asperities on the surface adopt surface roughness measured with a surface roughness meter as an indicator. The surface roughness of the surface of the second roller 72 is preferably equal to or above 2 μm and equal to or below 8 μm, or more preferably equal to or above 3 μm and equal to or below 6 μm in terms of arithmetic average roughness (Ra). On the other hand, the surface roughness is preferably equal to or above 15 μm and equal to or below 70 μm, or more preferably equal to or above 25 μm and equal to or below 50 μm in terms of the maximum height (Rz). The asperities on the surface of the second roller 72 may originate from a surface of the core bar or may originate from a surface of the superficial layer. These asperities are formed by blasting or thermal spraying, for example.

[0069] The first roller 71 includes the elastic intermediate layer as described above. Accordingly, when the web W is shaped by pinching the web W between the first roller 71 and the second roller 72, the asperities are apt to develop on the surface of the strip-shaped sheet P1 which comes into contact with the first roller 71. On the other hand, if the surface of the second roller 72 is made flat and smooth, the surface of the strip-shaped sheet P1 that comes into contact with the second roller 72 is apt to be flat and smooth. In this case, top and bottom surfaces of the strip-shaped sheet P1 are prone to bring about a difference in surface quality. This difference in surface quality may bring about a difference in smoothness between top and bottom surfaces of the sheet P3, and the top and bottom surfaces of the sheet P3 may need to be distinguished from each other when the sheet P3 is used as copy paper and the like.

[0070] On the other hand, the above-mentioned asperities on the surface of the second roller 72 reduces the difference in surface quality between the top and bottom surfaces of the strip-shaped sheet P1, so that the sheet P3 can be used without distinguishing between the top and bottom surfaces thereof. Moreover, followability of the web W with respect to the second roller 72 is improved in the course of bending the web W to be described later, so that the web W can be bent easily.

[0071] The second roller 72 is rotationally driven by a drive motor to be described later. The first roller 71 is a driven roller which is not driven by a motor or the like but works in conjunction with the rotation of the second roller

72. Accordingly, the first roller 71 is rotated in a direction opposite to that of the second roller 72 in side view from the -x direction.

[0072] The web W is heated and pressed while being pinched between the first roller 71 and the second roller 72, and is sent downstream. In other words, the web W is continuously passed through the sheet shaping portion 70, thereby being heated and press-formed. The web W is heated and pressed efficiently by using the first roller 71 and the second roller 72 as a pair of shaping members.

[0073] Having passed through the sheet shaping portion 70, the web W is changed from a soft state of containing relatively a lot of air to a state of an increased density with reduction of the air contained therein. Then, the fibers are bonded to one another with the bonding agent and the web W is shaped into the strip-shaped sheet P1. The strip-shaped sheet P1 is transported to the first unit group 101 by using not-illustrated rollers.

[0074] Here, the web W is formed by accumulating the mixture. However, the thickness of the web W is unstable in an initial stage of forming the web W, or in other words, in a region at the tip end of the web W. In general, the thickness at the tip end of the web W tends to be smaller than a thickness of a subsequent portion. If the aforementioned thickness is small, there is a possibility of incurring a problem such as adhesion to the first roller 71 or the second roller 72 and clogging of the sheet P1 in the transportation path. On the other hand, in the sheet manufacturing apparatus 1, the occurrence of the above-mentioned problem is prevented by subjecting the tip end of the web W to a folding operation to be described later, thereby doubling the tip end and increasing the thickness thereof. In the following description, a tip end on the downstream side in the direction of transportation of the web W may be simply referred to as the tip end of the web W in some cases.

[0075] The second humidifying portion 66 is disposed below the first humidifying portion 65. A publicly known evaporative humidification device is applicable to the second humidifying portion 66. A device configured to evaporate moisture by winding a wet non-woven fabric and the like, and thus to generate the humidified air is cited as an example of the evaporative humidification device.

[0076] The second humidifying portion 66 humidifies a predetermined region of the sheet manufacturing apparatus 1. The predetermined region includes one or more of the buffer tank 13, the separating portion 40, and the drum member 53 of the accumulating portion 50. To be more precise, the humidified air is supplied from the second humidifying portion 66 to the above-mentioned region by the intermediary of not-illustrated pipes. The humidified air suppresses electrostatic charge of the used paper C, the fibers, and the like in the respective constituents mentioned above, thus curbing adhesion of these substances to the aforementioned members due to the static electricity.

[0077] The draining portion 68 is a drain tank. The draining portion 68 collects and stores old water used by the first humidifying portion 65, the second humidifying portion 66, and the like. The draining portion 68 can be detached from the sheet manufacturing apparatus 1 as needed, so as to dispose of the water stored therein.

[0078] The strip-shaped sheet P1 transported to the first unit group 101 reaches the first cutting portion 81. The first cutting portion 81 cuts the strip-shaped sheet P1 in a direction orthogonal to the direction of transportation, or in a direction along the x axis, for example. The strip-shaped sheet P1 is cut into single-sheet-shaped sheets P2 by the first cutting portion 81. The single-sheet-shaped sheets P2 are transported from the first cutting portion 81 to the second cutting portion 82.

[0079] The second cutting portion 82 cuts each single-sheet-shaped sheet P2 in the direction of transportation, or in a direction along the y axis, for example. Specifically, the second cutting portion 82 cuts out two end portions in the x axis direction of the single-sheet-shaped sheet P2. Thus, the single-sheet-shaped sheet P2 is formed into the sheet P3 in a predetermined shape such as the A4 size and the A3 size.

[0080] The slit pieces S being the listing are generated when the second cutting portion 82 cuts the single-sheet-shaped sheet P2 into the sheets P3. The slit pieces S are transported substantially in the -y direction and reach the shredding portion 86 which is the shredder. The shredding portion 86 shreds the slit pieces S into shredded pieces, and supplies the shredded pieces to the confluent portion 17. A mechanism for measuring the shredded slit pieces S and to feed the shredded pieces to the confluent portion 17 may be installed between the shredding portion 86 and the confluent portion 17.

[0081] The sheets P3 are transported substantially upward and stacked on the tray 84. The sheets P3 are manufactured by the sheet manufacturing apparatus 1 as described above. For example, the sheets P3 can be used as an alternative to copy paper and the like.

2. Folding operation of web tip end

[0082] A description will be given of bending and folding operations of the tip end of the web W. As illustrated in FIG. 2, the folding operation of the web W by the sheet shaping portion 70 includes a first step S1, a second step S2, a third step S3, a fourth step S4, and a fifth step S5. These steps are executed in the enumerated order in accordance with control by the control unit 5. Now, the respective steps will be described below with reference to FIGs. 3 to 6. The description with reference to FIGs. 3 to 6 will discuss states in side view from the -x direction unless otherwise specified.

[0083] As illustrated in FIG. 3, in the first step S1, the second transporting portion 62 transports the web W downstream in the -y direction.

[0084] In the original shaping operation to pass the web W between the first roller 71 and the second roller 72, the second roller 72 is rotated in a counterclockwise rota-

tional direction R1 while the first roller 71 is rotated in a clockwise rotational direction R2. In the first step S1, the first roller 71 and the second roller 72 are rotated in the aforementioned directions, respectively, in advance as illustrated in FIG. 3.

[0085] Then, the operation proceeds to the second step S2 at a point when the tip end of the web W goes beyond a region opposed to the air injecting portion 200. Here, a method of determination as to whether or not the tip end of the web W reaches the region opposed to the air injecting portion 200 is fulfilled by detecting the position of the tip end of the web W by using an optical sensor. Meanwhile, as another method, it is also possible to adopt a method of carrying out a test measurement of time required from a point when the accumulating portion 50 starts driving to a point when the tip end of the web W reaches the position to oppose the air injecting portion 200 in advance, and conducting timing control while presetting the measured time.

[0086] As illustrated in FIG. 4, in the second step S2, the tip end of the web W is peeled off the transporting belt 62a. Specifically, in the second step S2, the tip end of the web W is peeled off the transporting belt 62a by injecting the pressurized air from the air injecting portion 200. The transportation of the web W by the transporting belt 62a is continued during this period. Accordingly, the tip end of the web W is suspended downward and comes into contact with the second roller 72.

[0087] In this instance, as illustrated in FIG.4, the operation to rotate the second roller 72 in the clockwise rotational direction R2 being a second direction may be started at a point of time when the tip end of the web W comes into contact with the second roller 72. In this case, the first roller 71 is driven by the second roller 72 and is rotated in the counterclockwise rotational direction R1.

[0088] In the second step S2, the tip end of the web W is peeled off the transporting belt 62a by the pressurized air, and moreover, the tip end of the web W is suspended substantially downward. This facilitates bending of the tip end of the web W in the subsequent third step S3. Then, the operation proceeds to the third step S3.

[0089] As illustrated in FIG. 5, in the third step S3, the second roller 72 is rotated in the rotational direction R2 being the second direction in the state where the tip end of the web W is in contact with the surface of the second roller 72. Accordingly, the tip end of the web W is pulled by the surface of the second roller 72 and is bent in the +y direction (a lower right direction in FIG. 5). In this instance, the first roller 71 is driven by the second roller 72 and is rotated in the counterclockwise rotational direction R1.

[0090] In the third step S3, rotation of the second roller 72 in the rotational direction R2 is stopped after a lapse of a predetermined period. Here, a distance of the tip end of the web W bent in the +y direction is adjusted by a diameter, a rotational speed, and rotation time of the second roller 72. Then, the operation proceeds to the fourth step S4.

[0091] As illustrated in FIG. 6, in the fourth step S4, the second roller 72 is rotated in the rotational direction R1 being a first direction opposite to the second direction, and the first roller 71 is driven and rotated in the rotational direction R2. At the same time, the web W is passed between the first roller 71 and the second roller 72 collectively constituting the pressing roller pair 700. Thus, the tip end of the web W is pressed and folded. Then, the operation proceeds to the fifth step S5.

[0092] In the fifth step S5 subsequent to the fourth step S4, the second roller 72 is continuously rotated in the rotational direction R1 while the first roller 71 is continuously rotated in the rotational direction R2, respectively. Accordingly, the web W is passed through and pressed by the pressing roller pair 700, and is heated by the first roller 71 and the second roller 72. Thus, the strip-shaped sheet P1 is continuously shaped. A transportation path for the strip-shaped sheet P1 is indicated with a dashed line in FIG. 6. Thereafter, the strip-shaped sheet P1 is transported toward the above-mentioned first cutting portion 81.

[0093] The distance of the fold at the tip end on the downstream side in the direction of transportation of the strip-shaped sheet P1, on in other words, a distance formed by the twofold of the web W only needs to be equal to or above 20 mm, for example. The above-mentioned distance is adjusted by the distance of the tip end of the web W to be bent in the third step S3.

[0094] Here, the tip end of the web W is not limited to be formed into the twofold. The tip end of the web W may be formed into a threefold or more by repeatedly carrying out the third step S3 and the fourth step S4 mentioned above. Thus, the thickness and strength at the tip end of the web W are further increased.

[0095] Meanwhile, in the above-described second step S2, the tip end of the web W may be bent in a spirally rolled fashion by adjusting the transportation speed of the web W after peeling off the tip end, the rotational speed of the second roller 72, and the like. In this way, the thickness of the web W is increased and the strength at the tip end of the web W is further increased.

3. Sheet shaping portion

[0096] Regarding the sheet shaping portion 70, a description will be given of a detailed configuration as well as functions including the folding of the web W mentioned above, detachment and contact of the first roller 71 and the second roller 72, and so forth.

[0097] As illustrated in FIGs. 7 and 8, the sheet shaping portion 70 includes a first roller retention unit 711, a base unit 721, the first roller 71, the second roller 72, a gear group 76, a drive motor 79, springs 794, and pins 735. In the meantime, the first roller 71 and the second roller 72 that are disposed in the +x direction of the first roller retention unit 711 or the base unit 721 are indicated with dashed lines in FIG. 8.

[0098] The first roller 71 is installed at the first roller

retention unit 711. As illustrated in FIG. 9, the first roller retention unit 711 has a substantially rectangular frame shape in plan view from the +z direction, and retains the first roller 71 on an inner side thereof. The first roller 71 is supported by the first roller retention unit 711 in such a way as to be rotatable about a not-illustrated central axis that extends along the x axis.

[0099] The first roller retention unit 711 is supported by the base unit 721 in such a way as to be rotatable about a shaft A1 as a rotation center in side view from the -x direction. Specifically, the shaft A1 extends along the x axis and is located substantially at a portion in the +y direction of the first roller 71 in side view from the -x direction. The first roller retention unit 711 is supported by the base unit 721 at a position where a side surface in the +x direction and a side surface in the -x direction intersect with the shaft A1.

[0100] The pins 735 are fixed to the side surface in the +x direction and the side surface in the -x direction of the first roller retention unit 711, respectively, thus forming a pair. One of the pair of pins 735 is provided to project from the above-mentioned side surface in the +x direction and the other one of the pair of pins 735 is provided to project from the above-mentioned side surface in the -x direction. In perspective view from the -x direction, the pair of pins 735 are disposed slightly below the first roller 71 in the -y direction.

[0101] Back to FIGs. 7 and 8, the base unit 721 supports the first roller retention unit 711 in the +z direction. Although illustration is omitted, the base unit 721 is fixed to a frame of the above-mentioned third unit group 103 by the intermediary of a sub-frame and the like. In the base unit 721, the drive motor 79 and the gear group 76 are disposed at a portion on the -x direction side of a side surface in the -x direction. Among gears in the gear group 76, the gears except a gear G1 are rotatably supported by the base unit 721 and the like by using not-illustrated members.

[0102] The second roller 72 is disposed at a portion in the +y direction of the base unit 721. The second roller 72 is supported by the base unit 721 in such a way as to be rotatable about a not-illustrated central axis that extends along the x axis. The second roller 72 is located at a portion in the -z direction and slightly in the +y direction of the first roller 71.

[0103] The springs 794 are disposed, respectively, on the -x direction side of side surfaces in the -x direction of the first roller retention unit 711 and the base unit 721, and on the +x direction side of side surfaces in the +x direction thereof although illustration is omitted.

[0104] Each of the pair of springs 794 is installed in such a way as to intersect with the x axis and the y axis. One end of each spring 794 is fixed to an end portion in the -y direction and in the +z direction of the first roller retention unit 711, and the other end of each spring 794 is fixed in the vicinity of an end portion in the -y direction of the base unit 721. Thus, the first roller retention unit 711 is biased in a counterclockwise direction on a circumference centered at the shaft A1 in side view from the -x direction. Using this biasing force, the first roller 71 comes into contact with the second roller 72.

[0105] The drive motor 79 is disposed substantially at the center of the base unit 721 in the direction along the y axis and in the vicinity of an end portion in the -z direction thereof in side view from the -x direction. The drive motor 79 includes a not-illustrated output shaft extending substantially along the y axis. The output shaft extends along the y axis and projects in the +y direction from a body of the drive motor 79. The gear G1 is directly connected to the output shaft. The drive motor 79 is rotatable in a counterclockwise forward direction and in a clockwise reverse direction when viewed from the +y direction.

[0106] The drive motor 79 a drive source that executes rotation of the second roller 72, contact and detachment operations of the first roller 71 with respect to the second roller 72, and the above-described operation to fold the tip end of the web W through the gear group 76. The drive motor 79 can adopt a stepping motor or other publicly known actuators, for example.

[0107] The gear group 76 includes the gear G1 to a gear G7 as a set of gears. The gear group 76 is disposed from the +y direction to the +z direction of the drive motor 79 in side view from the -x direction. In the gear group 76, the closest gear G1 to the farthest gear G7 are disposed in the ascending order of numbers affixed to the codes on a path to transmit a rotary drive force of the drive motor 79.

[0108] The gear G1 is a worm gear that is disposed in the +y direction relative to the drive motor 79. The gear G1 transmits the rotary drive force from the drive motor 79 to a gear G2.

[0109] The gear G2 is disposed in the -z direction relative to the gear G1. A not-illustrated rotating shaft of the gear G2 extends along the x axis. The gear G2 transmits the rotary drive force, which is transmitted from the gear G1, to a gear G3.

[0110] The gear G3 is disposed substantially in the +y direction relative to the gear G2. A not-illustrated rotating shaft of the gear G3 extends along the x axis. The gear G3 transmits the rotary drive force, which is transmitted from the gear G2, to a gear G4.

[0111] The gear G4 is disposed substantially in the +y direction relative to the gear G2. The gear G4 is an example of a second roller gear of the present disclosure, which is fixed to an end portion in the -x direction of the second roller 72. A not-illustrated rotating shaft of the gear G4 extends along the x axis. The rotation of the drive motor 79 is transmitted from the gear G2 to the gear G4 so as to rotate the second roller 72, and the gear G4 transmits the rotary drive force to a first transmission gear G5a of a gear G5.

[0112] The gear G5 includes the first transmission gear G5a and a one-way clutch gear G5b. The rotation of the gear G4 is transmitted to the first transmission gear G5a. As illustrated in FIG. 10, the first transmission gear G5a and the one-way clutch gear G5b are installed at the

same rotating shaft A2.

[0113] The rotating shaft A2 extends along the x axis. The one-way clutch gear G5b and the first transmission gear G5a are installed in this order at the rotating shaft A2 toward the +x direction. The rotating shaft A2 is rotatably supported by the base unit 721.

[0114] The first transmission gear G5a includes an idling mechanism that can run idle over a certain period. The first transmission gear G5a transmits the rotation of the gear G4 to the rotating shaft A2 while interposing idling for the aforementioned certain period. Details of the idling mechanism will be described later.

[0115] The one-way clutch gear G5b is rotated in the counterclockwise direction being the first direction by the rotation of the rotating shaft A2 in the first direction, and runs idle against the rotation in the second direction of the rotating shaft A2. The rotation of the one-way clutch gear G5b in the first direction is transmitted to the gear G7 serving as a cam gear through a gear G6.

[0116] Specifically, the rotation of the drive motor 79 is transmitted to the rotating shaft A2 through the gear G4, the first transmission gear G5a, and the like. The one-way clutch gear G5b runs idle when the drive motor 79 is rotated in the reverse direction and the rotating shaft A2 is rotated in the second direction. The one-way clutch gear G5b is rotated when the drive motor 79 is rotated in the forward direction and the rotating shaft A2 is rotated in the first direction, whereby the rotary drive force is transmitted to the gear G6.

[0117] The one-way clutch gear G5b can adopt publicly known techniques such as a cam system, a sprag system, and a planet gear system.

[0118] Back to FIGs. 7 and 8, the gear G6 is disposed substantially in the -y direction relative to the gear G5. A not-illustrated rotating shaft of the gear G6 extends along the x axis. The gear G6 transmits the rotary drive force, which is transmitted from the one-way clutch gear G5b, to the gear G7.

[0119] The gear G7 is disposed in the -y direction relative to the gear G6. A not-illustrated rotating shaft of the gear G7 extends along the x axis. The rotation of the one-way clutch gear G5b is transmitted to the gear G7 through the gear G6. As illustrated in FIG. 11, the gear G7 is installed at a cam connection shaft 771. A cam C17 is disposed at a portion in the +x direction relative to the gear G7. The cam C17 is disposed coaxially with the gear G7. That is to say, the gear G7 and the cam C17 are fixed to the cam connection shaft 771. The cam C17 can come into contact with the pin 735, which is fixed to a portion in the -x direction of the first roller retention unit 711.

[0120] The pin 735 performs positioning of the above-described first roller retention unit 711 by coming into contact with the cam C17.

[0121] The cam connection shaft 771 extends along the x axis. Although illustration is omitted, another cam C17 is fixed to a portion in the +x direction of the cam connection shaft 771. Specifically, the cam connection shaft 771 penetrates a side surface in the -x direction of the base unit 721 and extends in the +x direction. An end portion in the +x direction of the cam connection shaft 771 penetrates a side surface in the +x direction of the base unit 721. The cam C17 is also fixed to the above-mentioned end portion. The cam C17 at the above-mentioned end portion can come into contact with the pin 735 that is fixed to a portion in the x direction of the first roller retention unit 711.

[0122] Each cam C17 is an eccentric cam. The cams C17 that form a pair are rotated in conjunction with the rotation of the gear G7 through the cam connection shaft 771. In this way, each cam C17 repeats contact and detachment with respect to the corresponding pin 735 when the gear G7 is rotated.

[0123] In the present embodiment, the cam C17 fixed to the portion in the -x direction of the cam connection shaft 771 is fixed to the gear G7. Nonetheless, this cam C17 does not always have to be fixed to the gear G7.

[0124] As illustrated in FIG. 12, the first transmission gear G5a includes an idling mechanism 75. The idling mechanism 75 of the first transmission gear G5a includes a contact plate 751 and a pair of cutouts 752.

[0125] The pair of cutouts 752 cause the first transmission gear G5a to run idle with respect to the rotating shaft A2. The pair of cutouts 752 are provided inside the first transmission gear G5a. The pair of cutouts 752 are disposed in such a way as to overlap each other when the cutouts 752 are turned about a rotation center of the rotating shaft A2 by 180°. Each cutout 752 has a substantially fan-like shape in side view from the -x direction. When the shape of each cutout 752 is regarded as the fan shape, a central angle of the fan is equal to 90°.

[0126] Here, regarding each cutout 752, inner edges along radial directions of the fan shape will be defined as edge portions 752a and 752b. The first transmission gear G5a is not fixed to the rotating shaft A2 and the contact plate 751. Accordingly, the rotation of the first transmission gear G5a is transmitted to the rotating shaft A2 by causing the respective edge portions 752a or edge portions 752b to come into contact with the contact plate 751.

[0127] The contact plate 751 is of a plate-like shape, which is disposed inside the pair of cutouts 752 and is fixed to the rotating shaft A2. When the rotation is transmitted from the gear G4 to the first transmission gear G5a, the first transmission gear G5a is either rotated or runs idle for a certain period depending on positional relations between the contact plate 751 and the edge portions 752a or between the contact plate 751 and the edge portions 752b.

[0128] In the state illustrated in FIG. 12, when the first transmission gear G5a is rotated in the second direction (clockwise), the first transmission gear G5a does not run idle since the respective edge portions 752b are in contact with the contact plate 751. That is to say, the rotation of the first transmission gear G5a is immediately transmitted to the rotating shaft A2. On the other hand, when the first transmission gear G5a is rotated in the second direction from the state where the respective edge por-

tions 752a are in contact with the contact plate 751, the rotating shaft A2 is rotated after running idle for a certain period. That is to say, the rotation of the first transmission gear G5a is not transmitted to the rotating shaft A2 until the contact plate 751 moves relative to the pair of cutouts 752 and the contact plate 751 comes into contact with the respective edge portions 752b.

[0129] Meanwhile, in the state illustrated in FIG. 12, when the first transmission gear G5a is rotated in the first direction (counterclockwise), the rotating shaft A2 is rotated after running idle for a certain period. That is to say, the rotation of the first transmission gear G5a is not transmitted to the rotating shaft A2 until the contact plate 751 moves relative to the pair of cutouts 752 and the contact plate 751 comes into contact with the respective edge portions 752a. Then, as the first transmission gear G5a is further rotated in the first direction and the respective edge portions 752a come into contact with the contact plate 751, the rotation of the first transmission gear G5a is transmitted to the rotating shaft A2.

[0130] On the other hand, the rotating shaft A2 is immediately rotated when the first transmission gear G5a is rotated in the first direction from the state where the respective edge portions 752a are in contact with the contact plate 751. The present embodiment conforms the aforementioned certain period to the predetermined period to rotate the second roller 72 in the rotational direction R2 in the above-mentioned third step S3.

[0131] As described above, when the first transmission gear G5a is rotated, the first transmission gear G5a runs idle with respect to the rotating shaft A2 before the edge portions 752a and 752b of the cutouts 752 come into contact with the contact plate 751. Then, the edge portions 752a and 752b of the cutouts 752 come into contact with the contact plate 751, and the first transmission gear G5a rotates the rotating shaft A2.

[0132] To be more precise, when the gear G4 is rotated in the rotational direction R1 being the first direction, the first transmission gear G5a is rotated in the rotational direction R2 being the second direction as illustrated in FIG. 13. In this instance, the rotating shaft A2 is rotated in the rotational direction R2 after the first transmission gear G5a runs idle just for the certain period before the respective edge portions 752b come into contact with the contact plate 751. In FIG. 13, the respective edge portions 752b are in contact with the contact plate 751. Accordingly, the first transmission gear G5a rotates the rotating shaft A2 in the rotational direction R2 without running idle.

[0133] Meanwhile, when the gear G4 is rotated in the rotational direction R2 being the second direction, the first transmission gear G5a is rotated in the rotational direction R1 being the first direction as illustrated in FIG. 14. In this instance, the rotating shaft A2 is rotated in the rotational direction R1 after the first transmission gear G5a runs idle just for the certain period before the respective edge portions 752a come into contact with the contact plate 751. In FIG. 14, the respective edge portions 752a are in contact with the contact plate 751. Accordingly, the first transmission gear G5a rotates the rotating shaft A2 in the rotational direction R1 without running idle.

[0134] A description will be given below of various operations of the sheet shaping portion 70 by the intermediary of the drive motor 79, the gear group 76, and the like. The following description will discuss a state in side view from the -x direction unless otherwise specifically stated. Note that in FIGs. 15, 17, 20, and 22 to be referred to, illustration of the constituents other than the cam C17, the gear G7, the pin 735, the shaft A1, the first roller retention unit 711, the base unit 721, the first roller 71, and the second roller 72 will be omitted for the convenience of illustration.

[0135] When operating the sheet manufacturing apparatus 1, the sheet shaping portion 70 carries out an operation preparatory action. Specifically, when pausing the sheet manufacturing apparatus 1, the first roller 71 is detached from the second roller 72 as illustrated in FIG. 15. To be more precise, the pin 735 comes into contact with and runs on the cam C17. Accordingly, a portion in the -y direction of the first roller retention unit 711 rises upward with respect to the base unit 721 while using the shaft A1 as a fulcrum. As a consequence, the first roller 71 is slightly detached from the second roller 72. In this instance, a clearance between a surface of the first roller 71 and a surface of the second roller 72 is set in a range from about 2 to 5 mm, for example. Here, the pin comes into contact with a dent at an upper portion of the cam C17, whereby a position of the first roller retention unit 711 is fixed.

[0136] In the state mentioned above, the first roller 71 is brought into contact with the second roller 72 by carrying out the operation preparatory action. First, the drive motor 79 is rotated in the forward direction (counterclockwise), whereby the gear G4 is rotated in the second direction (clockwise) as illustrated in FIG. 16. Thus, the one-way clutch gear G5b is rotated in the first direction (counterclockwise) and the gear G7 is also rotated in the first direction through the gear G6.

[0137] Then, as illustrated in FIG. 17, the cam C17 is also rotated in the first direction in conjunction with the rotation of the gear G7. The cam C17 is detached from the pin 735 as a consequence of the rotation of the cam C17. In the state where the cam C17 and the pin 735 are detached from each other, a gap between the can and the pin only needs to be about 2 mm. Then, the first roller retention unit 711 descends with the biasing force of the spring 794 by using the shaft A1 as the fulcrum. Thus, the first roller 71 also moves substantially downward and the first roller 71 comes into contact with the second roller 72. By operating the sheet manufacturing apparatus 1 in this state, the above-described web W is pressed by the first roller 71 and the second roller 72.

[0138] As described above, the cam C17 is rotated at a predetermined angle in conjunction with the rotation of the gear G7, thereby causing the first roller retention unit

711 to ascend or descend by the intermediary of the pin 735. The aforementioned predetermined angle is set to 180° in the present embodiment. However, this angle may be set to other angles instead. Here, the contact and detachment between the cam C17 and the pin 735 interlock between the +x direction side and the -x direction side of the sheet shaping portion 70. Meanwhile, the contact and detachment between the first roller 71 and the second roller 72 can be determined more accurately by detecting an angle of rotation of the cam C17 with a location sensor.

[0139] Next, when forming the strip-shaped sheet P1, the above-described bending of the tip end of the web W is carried out to begin with. In the operation to bend the tip end of the web W, the drive motor 79 is rotated in the forward direction and the gear G4 is rotated in the second direction as illustrated in FIG. 18. In this instance, the rotation of the drive motor 79 in the forward direction is set shorter than the certain period in which the first transmission gear G5a runs idle. Accordingly, although the first transmission gear G5a is rotated by the gear G4, the first transmission gear G5a runs idle for the certain period with respect to the above-mentioned rotating shaft A2 by the aforementioned idling mechanism 75, and the rotary drive force is not transmitted beyond the rotating shaft A2. As a consequence, the first roller retention unit 711 does not move since the cam C17 is not rotated. On the other hand, since the gear G4 is rotated in the second direction, the second roller 72 is rotated in the second direction whereby the tip end of the web W is bent in accordance with the above-described mechanism.

[0140] Next, the bent tip end of the web W is subjected to folding. The folding operation is the same as the operation to form the strip-shaped sheet P1, and the operation to form the strip-shaped sheet P1 is carried out subsequent to the folding operation.

[0141] In the operation to fold the tip end of the web W, the drive motor 79 is rotated in the reverse direction (clockwise) and the gear G4 is rotated in the first direction as illustrated in FIG. 19. In this instance, although first transmission gear G5a is rotated by the gear G4 so as to rotate the above-described rotating shaft A2 in the second direction, the rotating shaft A2 runs idle with respect to the one-way clutch gear G5b. For this reason, the rotary drive force is not transmitted beyond the one-way clutch gear G5b. As a consequence, the first roller retention unit 711 does not move since the cam C17 is not rotated.

[0142] On the other hand, since the gear G4 is rotated in the first direction, the second roller 72 is rotated in the first direction while the first roller 71 is rotated in the second direction. Accordingly, the bent tip end of the web W is passed between the first roller 71 and the second roller 72 whereby the tip end is folded. In addition, by continuously rotating the drive motor 79 in the reverse direction, the strip-shaped sheet P1 is formed by pressing a region subsequent to the tip end of the web W.

[0143] A pre-pause action of the sheet shaping portion 70 is carried out when pausing the sheet manufacturing apparatus 1. Specifically, when operating the sheet manufacturing apparatus 1, the first roller 71 is brought into contact with the second roller 72 as illustrated in FIG. 20. To be more precise, the cam C17 is located away from the pin 735. Accordingly, the portion in the -y direction of the first roller retention unit 711 descends while using the shaft A1 as the fulcrum, whereby the first roller 71 is in contact with the second roller 72. In this state, the first roller 71 is detached from the second roller 72 by carrying out the pre-pause action.

[0144] First, as illustrated in FIG. 21, the drive motor 79 is rotated in the forward direction and the gear G4 is rotated in the second direction. In this instance, the rotation of the first transmission gear G5a is transmitted to the rotating shaft A2 by continuously rotating the gear G4 in excess of an idling period of the first transmission gear G5a. Thus, the one-way clutch gear G5b is rotated in the first direction and the gear G7 is also rotated in the first direction through the gear G6.

[0145] Then, as illustrated in FIG. 22, the cam C17 is also rotated in the first direction in conjunction with the rotation of the gear G7. As a consequence of the rotation of the cam C17, the pin 735 comes into contact with and runs on the cam C17. Accordingly, the portion in the -y direction of the first roller retention unit 711 rises upward with respect to the base unit 721 against the bias from the above-described spring 794 while using the shaft A1 as the fulcrum. As a consequence, the first roller 71 also moves substantially upward whereby the first roller 71 is detached from the second roller 72. The sheet manufacturing apparatus 1 is paused in this state.

[0146] The following effects are available from the present embodiment.

[0147] Even in the case where the tip end of the web W becomes thin in the accumulating portion 50 at an initial stage of forming the web W, it is possible to prevent a problem that may occur due to the thin tip end. Specifically, since the tip end of the web W is folded, the web W is doubled at the tip end thereof. Accordingly, the thickness and intensity sufficient for reducing the chance of occurrence of a program as the web W are secured even when the tip end of the web W is thin before being folded.

[0148] Meanwhile, the operations as described above are realized with a small number of components and a reduction in size of the apparatus is realized at the same time. Specifically, the tip end of the web W is bent by the rotation in the forward direction of the drive motor 79. Subsequently, the rotation in the forward direction of the drive motor 79 is switched to the rotation in the reverse direction before exceeding the certain period in which the idling mechanism 75 runs idle. Then, the bent tip end of the web W is passed through the first roller 71 and the second roller 72 and is folded. Then, the region subsequent to the tip end of the web W is pressed and the strip-shaped sheet P1 is formed accordingly. In this way, the operation to fold the tip end of the web W and the operation to form the strip-shaped sheet P1 from the web W are

carried out by using the drive motor 79 alone. In this instance, the rotation in the reverse direction of the drive motor 79 is not transmitted to the gear G7 being the cam gear due to the idling of the one-way clutch gear G5b.

[0149] Moreover, when the rotation of the above-described drive motor 79 in the forward direction is continued in excess of the certain period in which the idling mechanism 75 runs idle, the gear G7 is rotated through the one-way clutch gear G5b and the cam C17 comes into contact with the pin 735. Thereafter, when the cam C17 moves the first roller retention unit 711 upward together with the pin 735, the first roller 71 is detached from the second roller 72. When the above-described operation is carried out before pausing the sheet manufacturing apparatus 1, the first roller 71 is located away from the second roller 72 during the pause so that respective components are kept from deformation and wear. Moreover, since the drive motor 79 is used for detaching the first roller 71 from the second roller 72, it is not necessary to provide a driving mechanism in addition to the drive motor 79, so that an increase in the number of components can be suppressed. As described above, it is possible to prevent the occurrence of a problem even when the tip end of the web W is thin, and to realize a reduction in size of the sheet manufacturing apparatus 1 at the same time.

Claims

1. A sheet manufacturing apparatus comprising:

a defibrator that defibrates a material containing a fiber and generates a defibrated material;
a accumulating portion that forms a web by accumulating the defibrated material; and
a sheet shaping portion that includes a first roller and a second roller, and forms a sheet by pressing the web, wherein
the sheet shaping portion includes

a first roller retention unit at which the first roller is installed,
a drive motor that is configured to be rotated in a forward direction and a reverse direction,
a second roller gear that receives transmission of rotation of the drive motor and rotates the second roller,
a first transmission gear that receives transmission of rotation of the second roller gear,
a one-way clutch gear installed at a rotating shaft common to the first transmission gear,
a cam gear that receives transmission of rotation of the one-way clutch gear,
a cam installed coaxially with the cam gear, and
a pin that is fixed to the first roller retention unit and performs positioning of the first roller retention unit by coming into contact with the cam, and

the first transmission gear includes an idling mechanism configured to run idle over a certain period.

2. The sheet manufacturing apparatus according to claim 1, wherein

the idling mechanism of the first transmission gear includes
a cutout provided to the first transmission gear, and
a contact plate fixed to the rotating shaft in such a way as to correspond to the cutout.

3. The sheet manufacturing apparatus according to claim 2, wherein

the first transmission gear runs idle with respect to the rotating shaft until an edge portion of the cutout comes into contact with the contact plate, and
the first transmission gear rotates the rotating shaft when the edge portion of the cutout comes into contact with the contact plate.

4. The sheet manufacturing apparatus according to claim 1, wherein

the one-way clutch gear runs idle when rotation in the reverse direction of the drive motor is transmitted to the rotating shaft through the second roller gear and the rotating shaft is rotated in a second direction, and
the one-way clutch gear is rotated when rotation in the forward direction of the drive motor is transmitted to the rotating shaft and the rotating shaft is rotated in a first direction being opposite to the second direction.

5. The sheet manufacturing apparatus according to claim 1, wherein the cam causes the first roller retention unit to ascend or descend through the pin by being rotated at a predetermined angle.

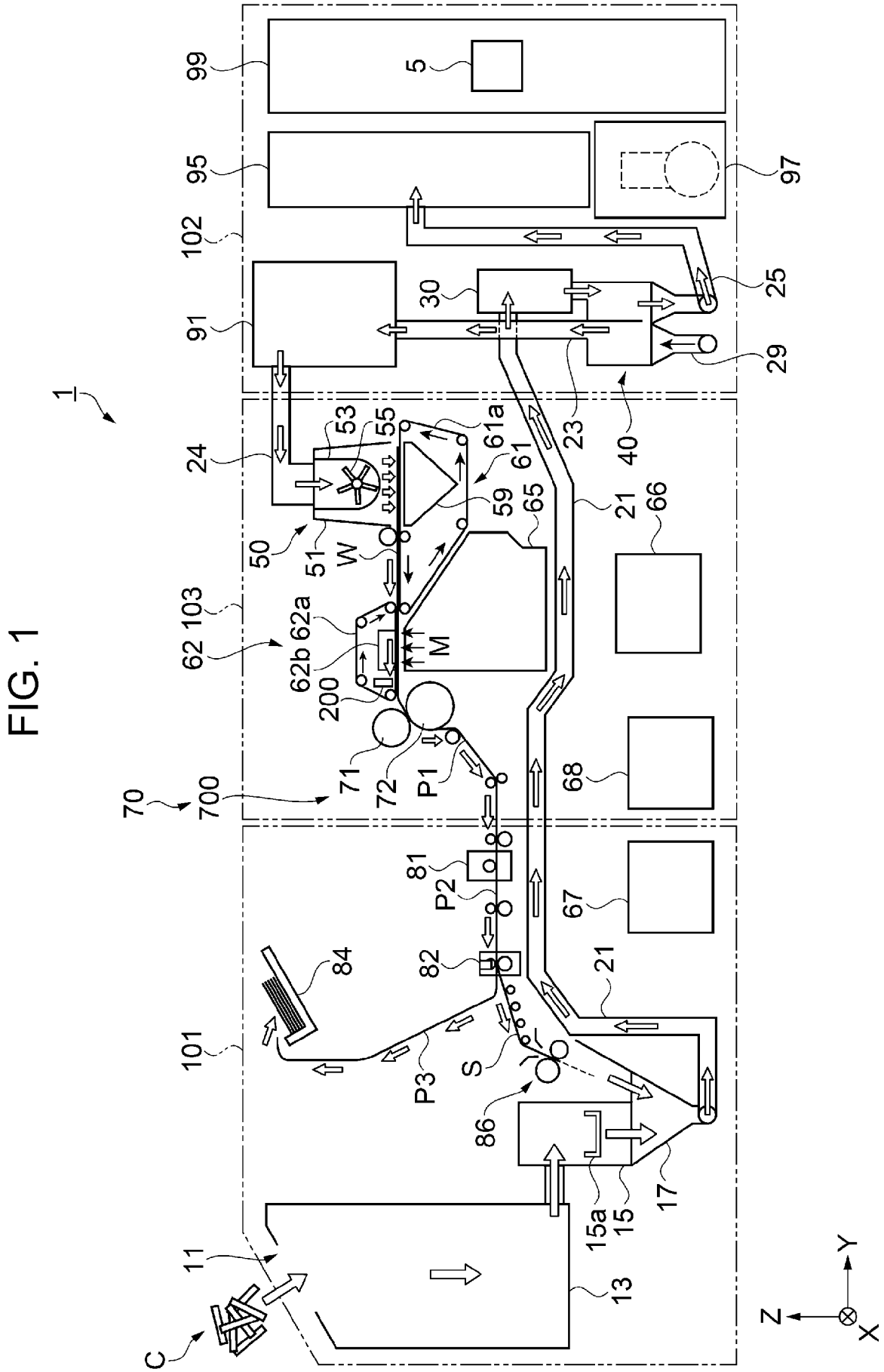
6. The sheet manufacturing apparatus according to claim 5, wherein

the first roller retention unit descends to bring the first roller into contact with the second roller, and the web is pressed by the first roller and the second roller.

7. The sheet manufacturing apparatus according to claim 6, wherein the cam is an eccentric cam.

8. The sheet manufacturing apparatus according to claim 7, wherein the cam is fixed to the cam gear.

FIG. 1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23
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61a
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59
65
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66
50
51
W
62 103
62a
62b
M
200
71
72
P1
70
700
68
81
P2
67
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101
P3
S
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15a
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11
13
C
Y
Z
X

FIG. 2

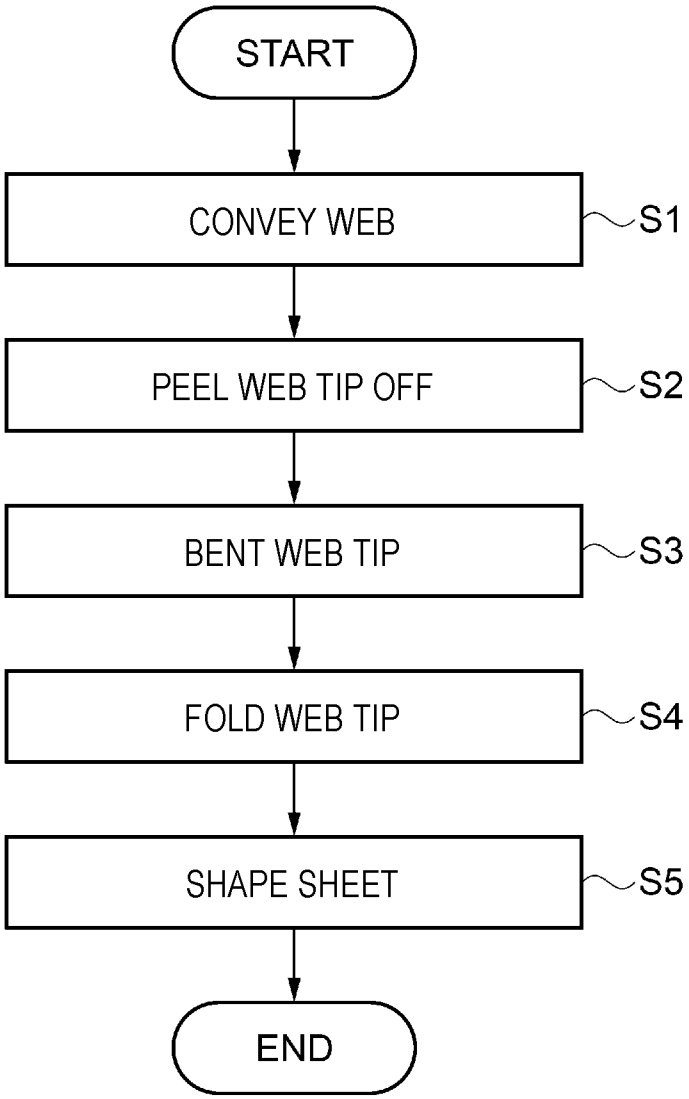
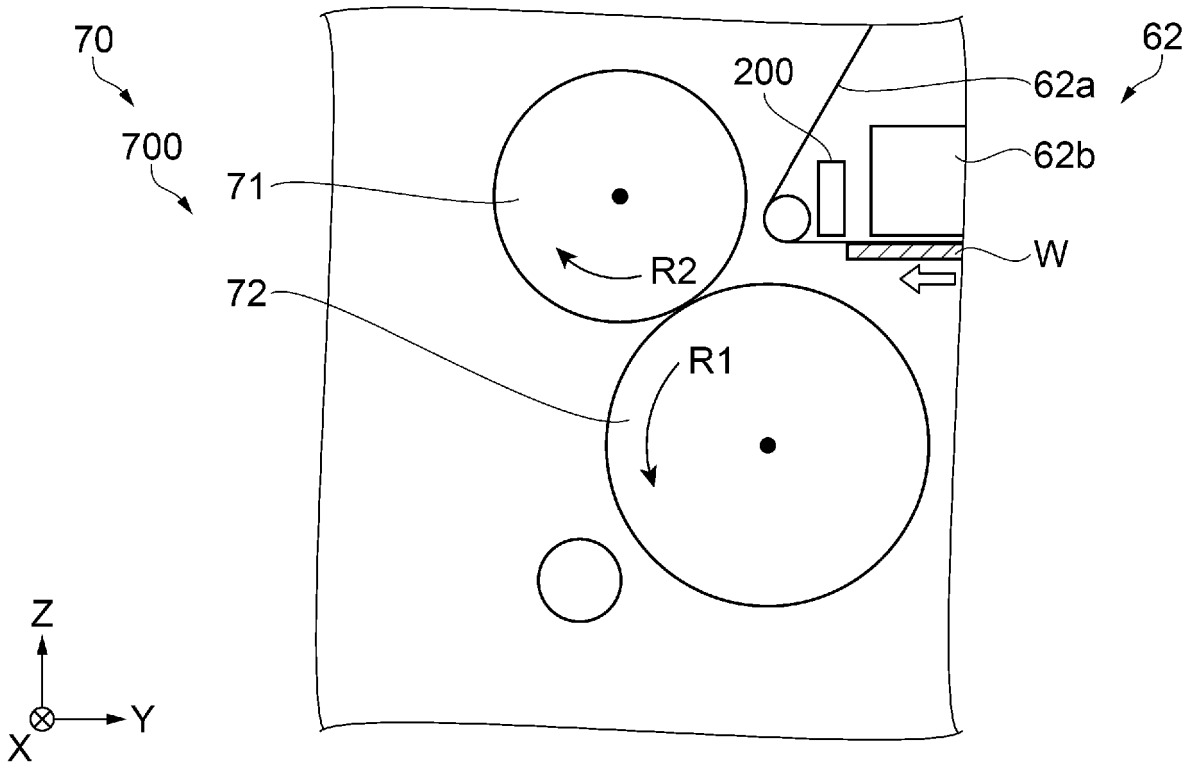

START
CONVEY WEB
S1
PEEL WEB TIP OFF
S2
BENT WEB TIP
S3
FOLD WEB TIP
S4
SHAPE SHEET
S5
END

FIG. 3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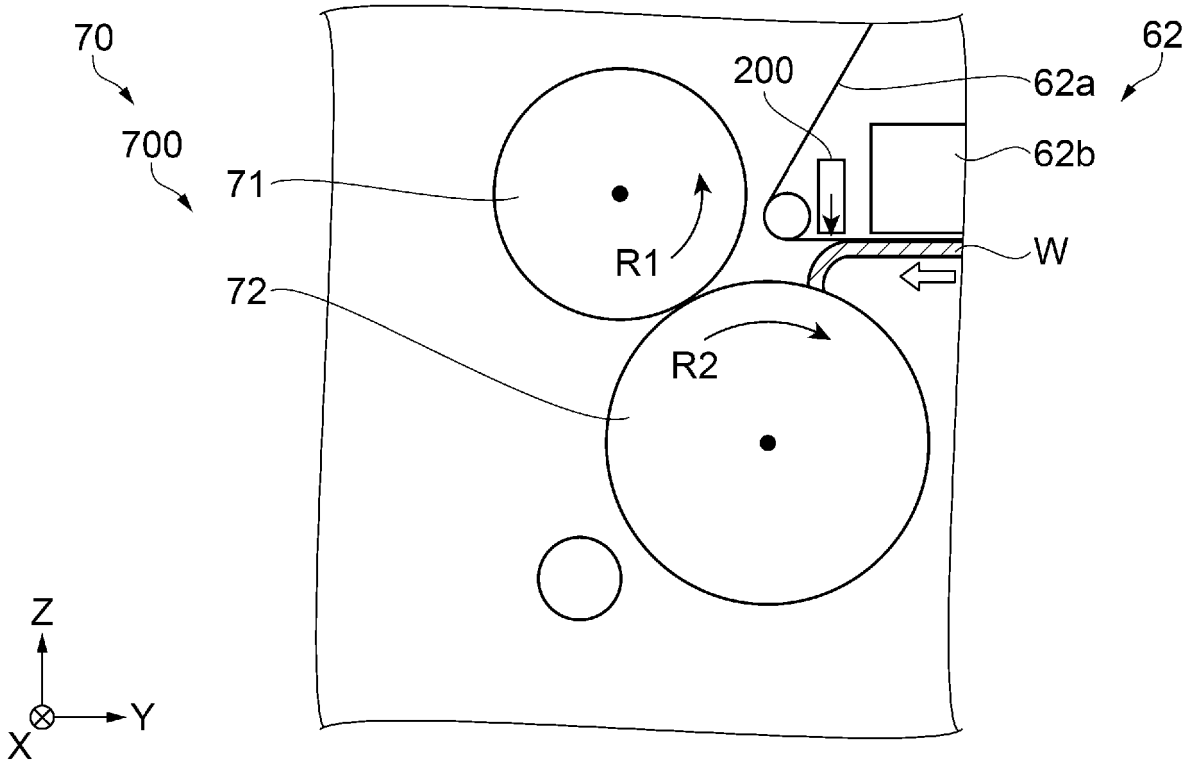
700
71
72
200
62
62a
62b
W
R2
R1
Z
Y
X

FIG. 4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62a
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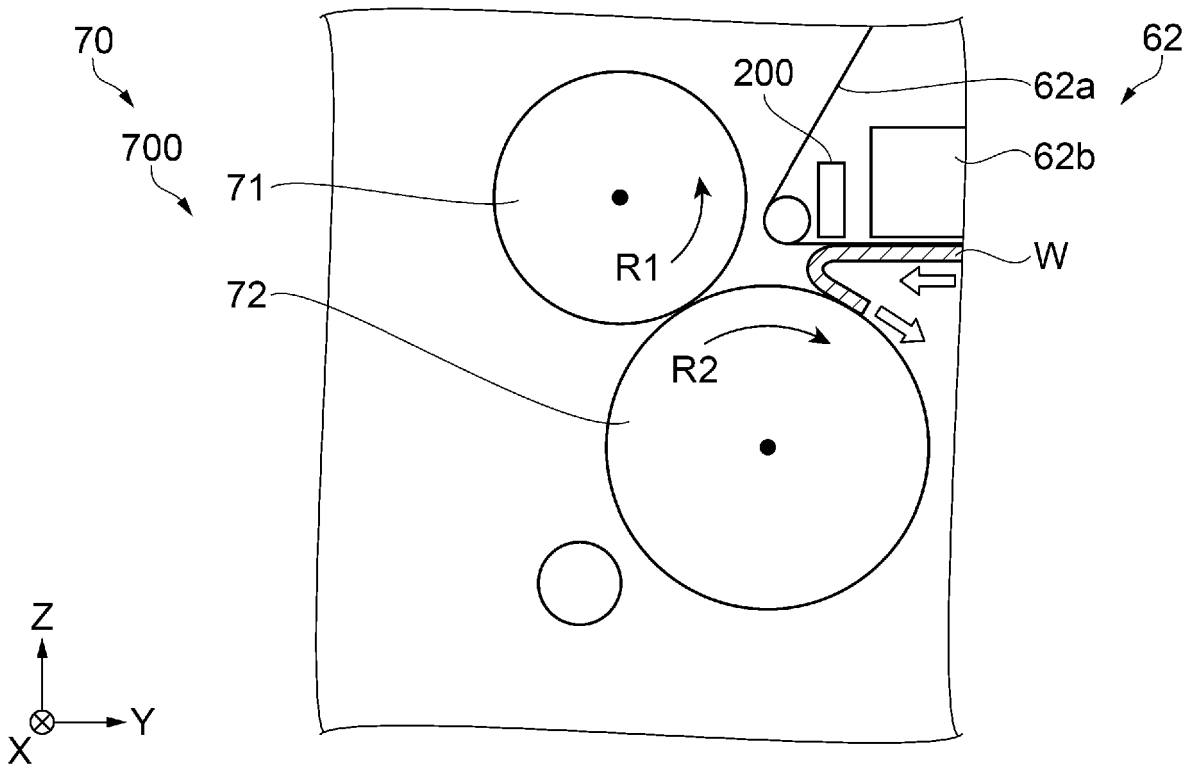
W
R1
R2
Z
Y
X

FIG. 5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200
62
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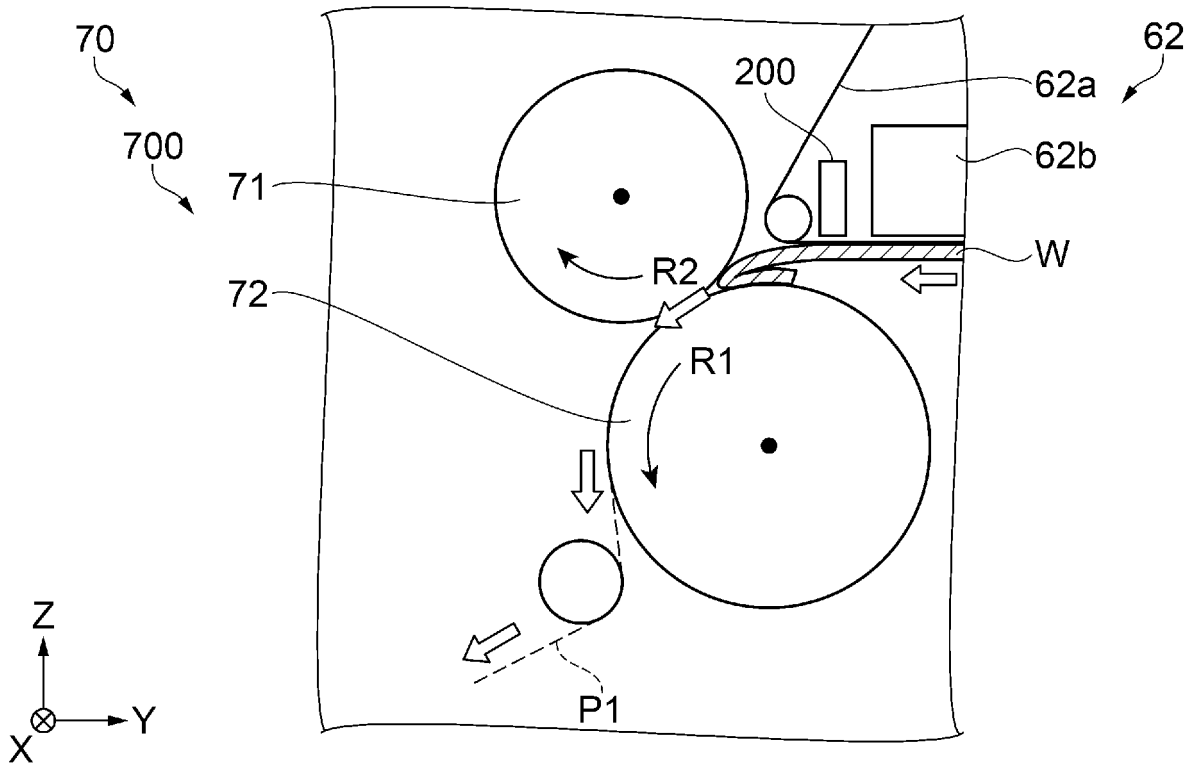
62b
W
R1
R2
Z
Y
X

FIG. 6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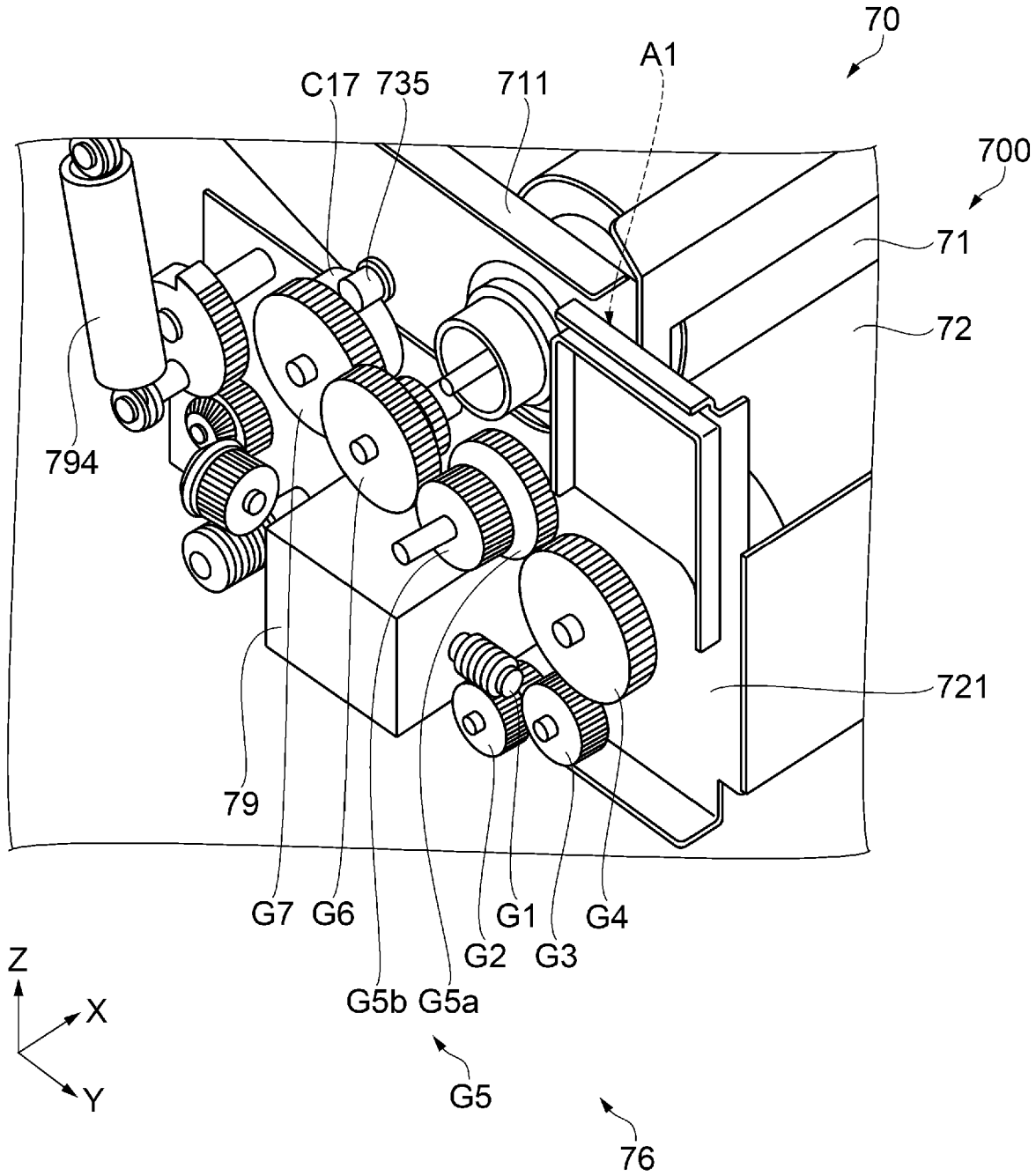
200
62
62a
62b
W
R2
R1
P1
Z
Y
X

FIG. 7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A1
C17
735
711
700
71
72
794
721
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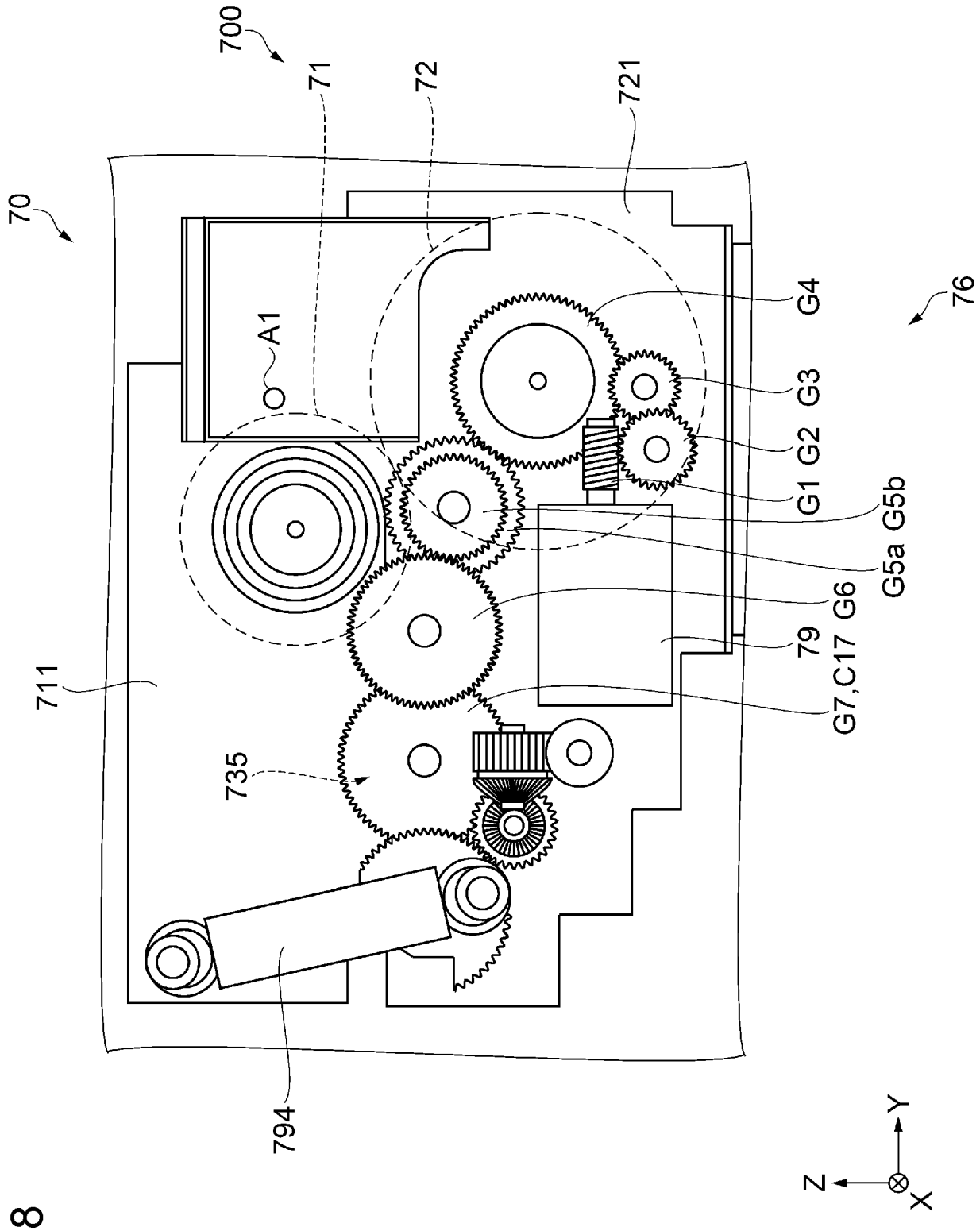
G7
G6
G1
G4
G2
G3
G5b
G5a
G5
76
Z
X
Y


700
71
72
721
70
A1
G4
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G3
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G6
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C17
G7,
711
735
794
Y
Z
X

FIG. 8

FIG. 9

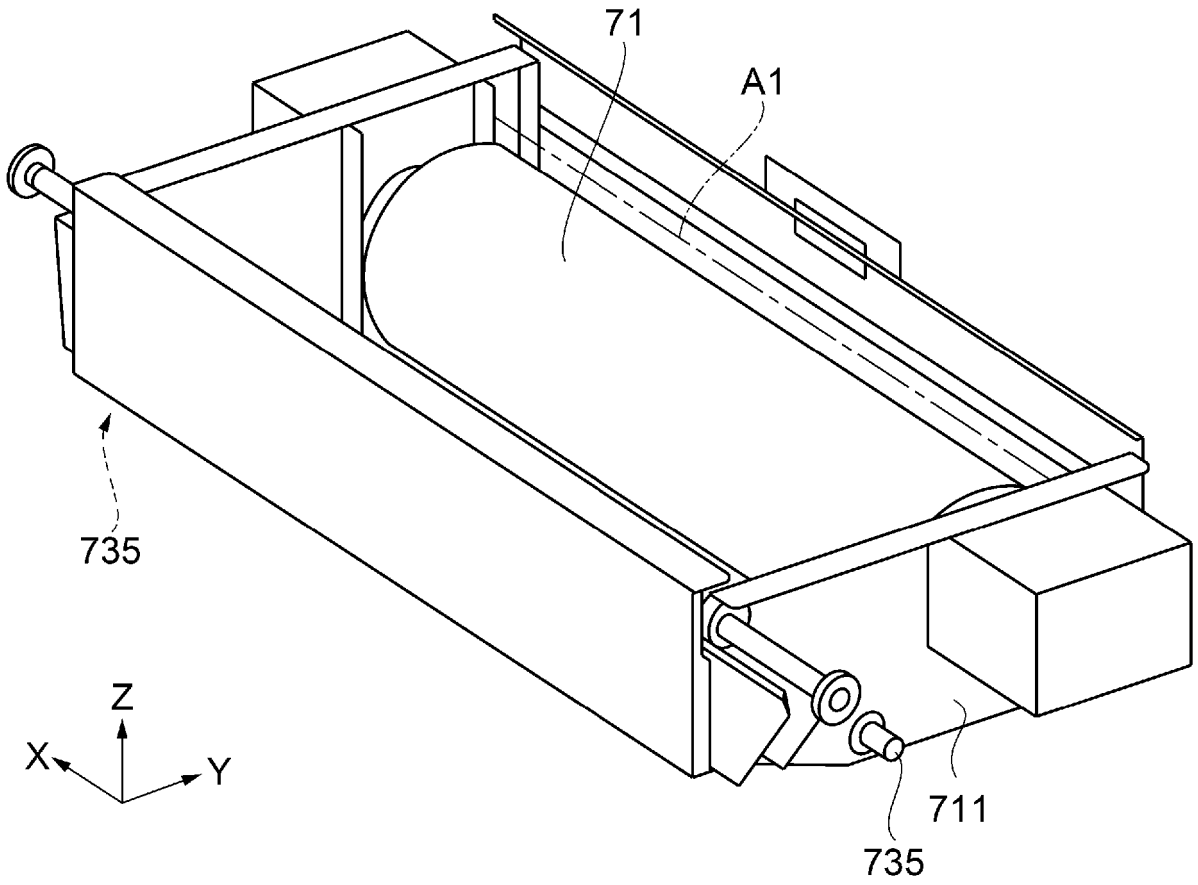


FIG. 10

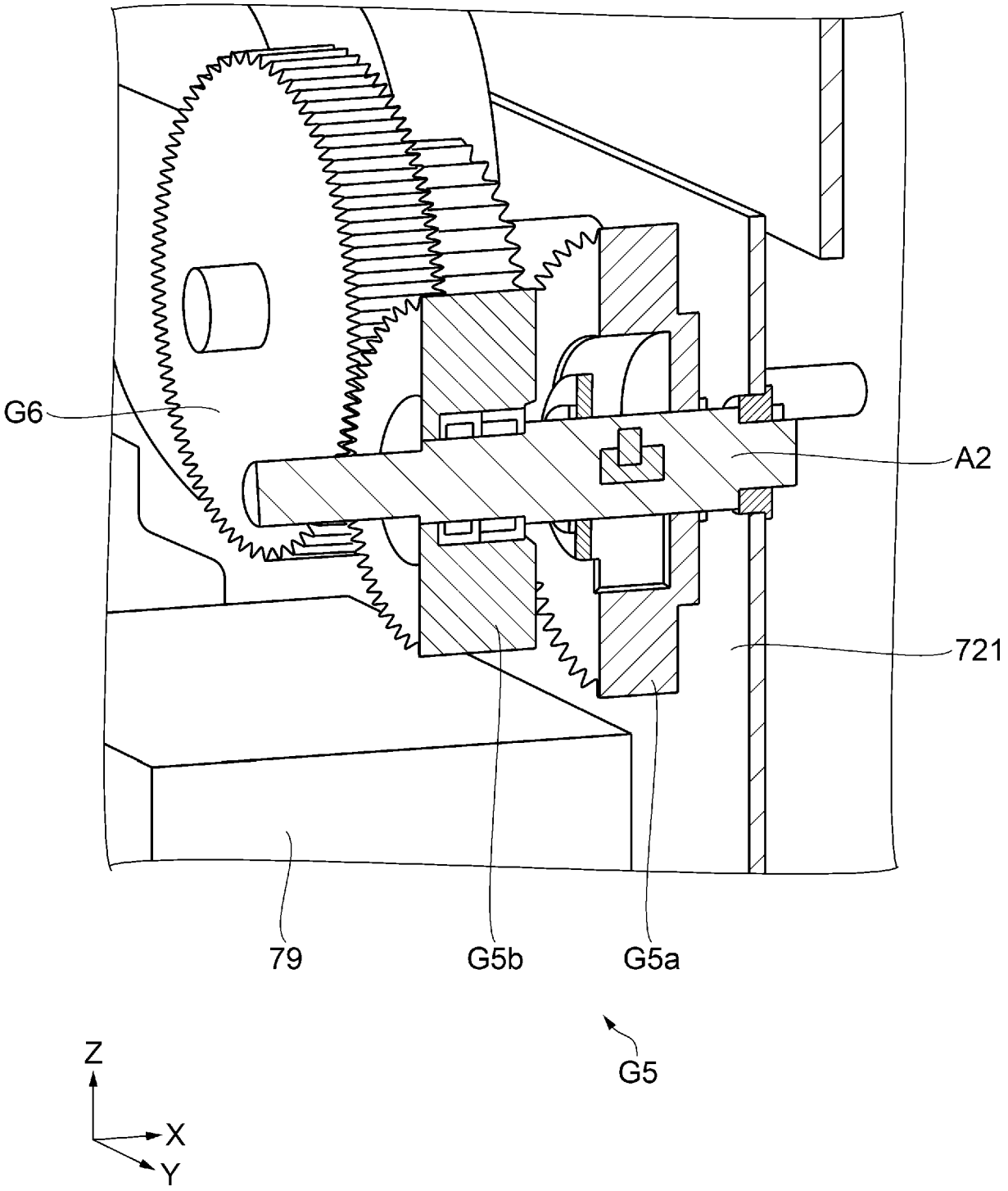


FIG. 11

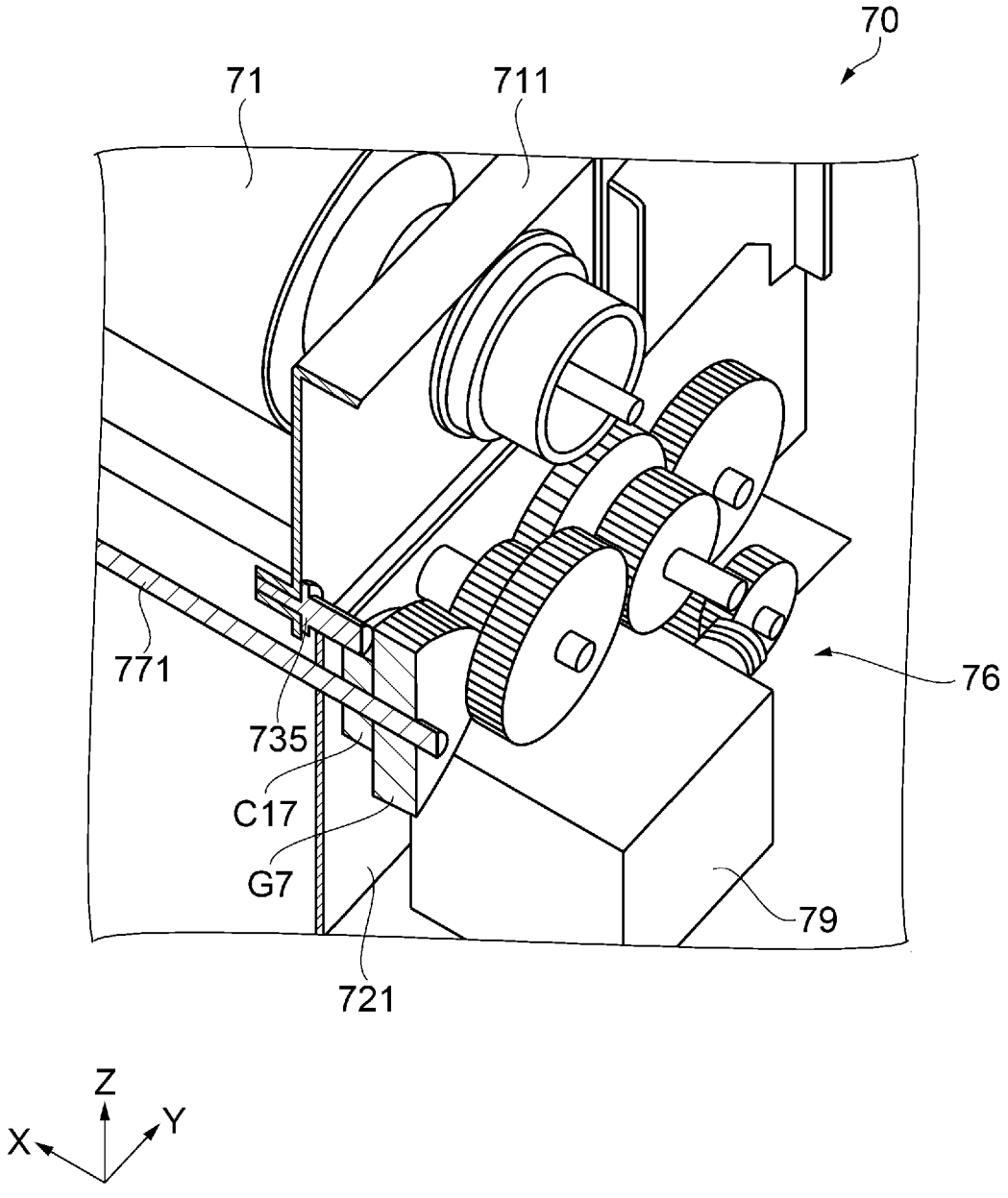


FIG. 12

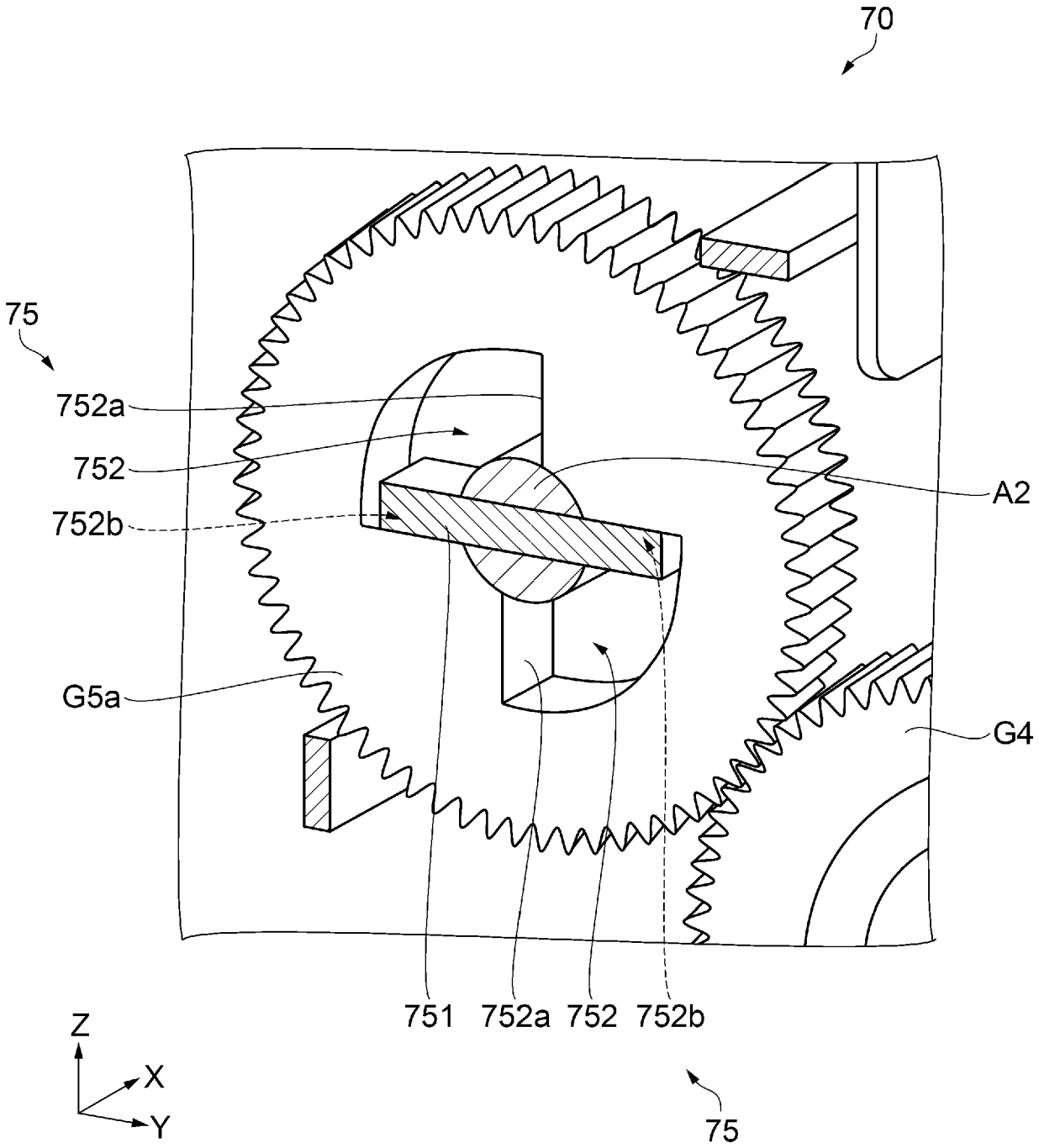


FIG. 13

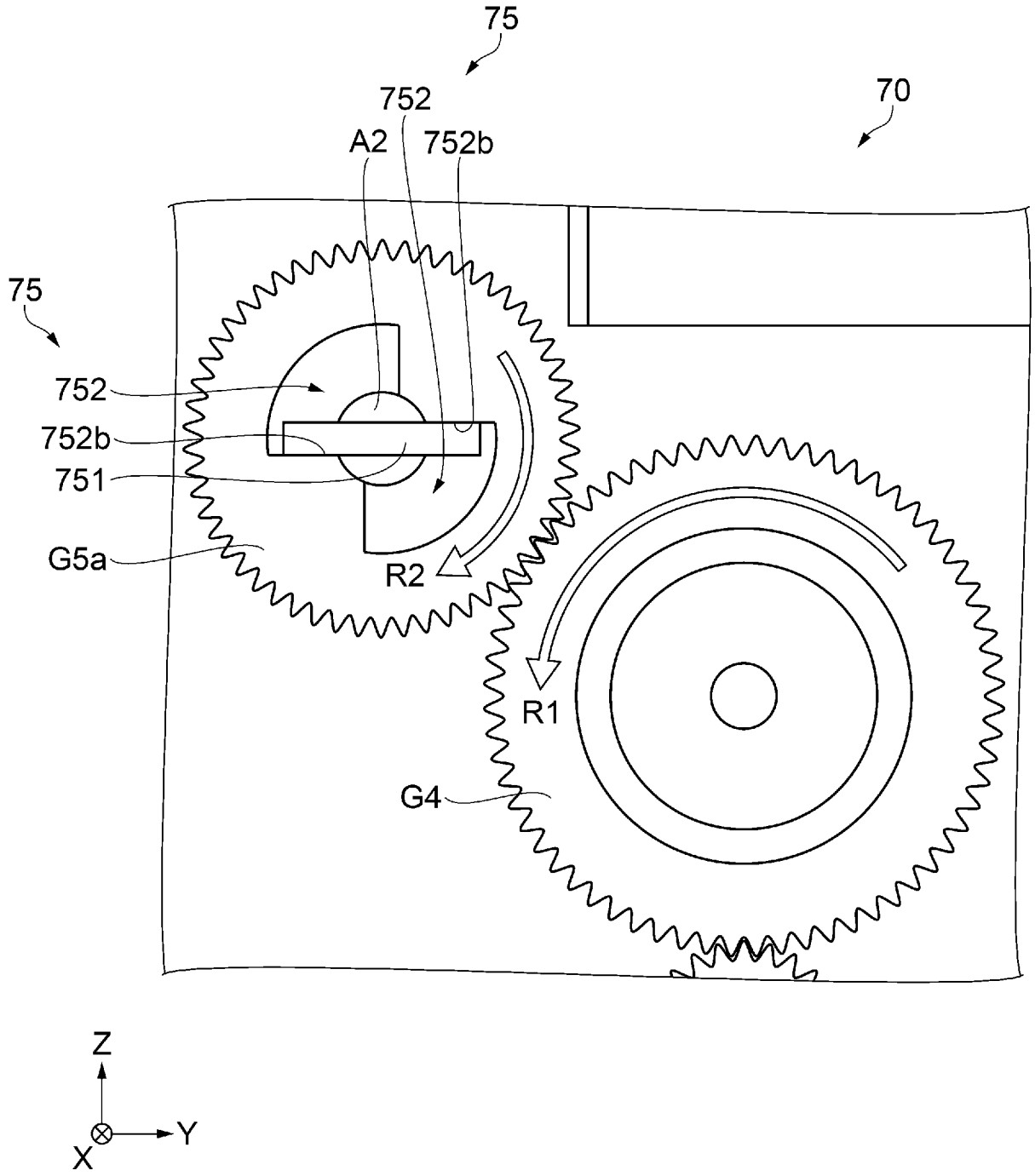


FIG. 14

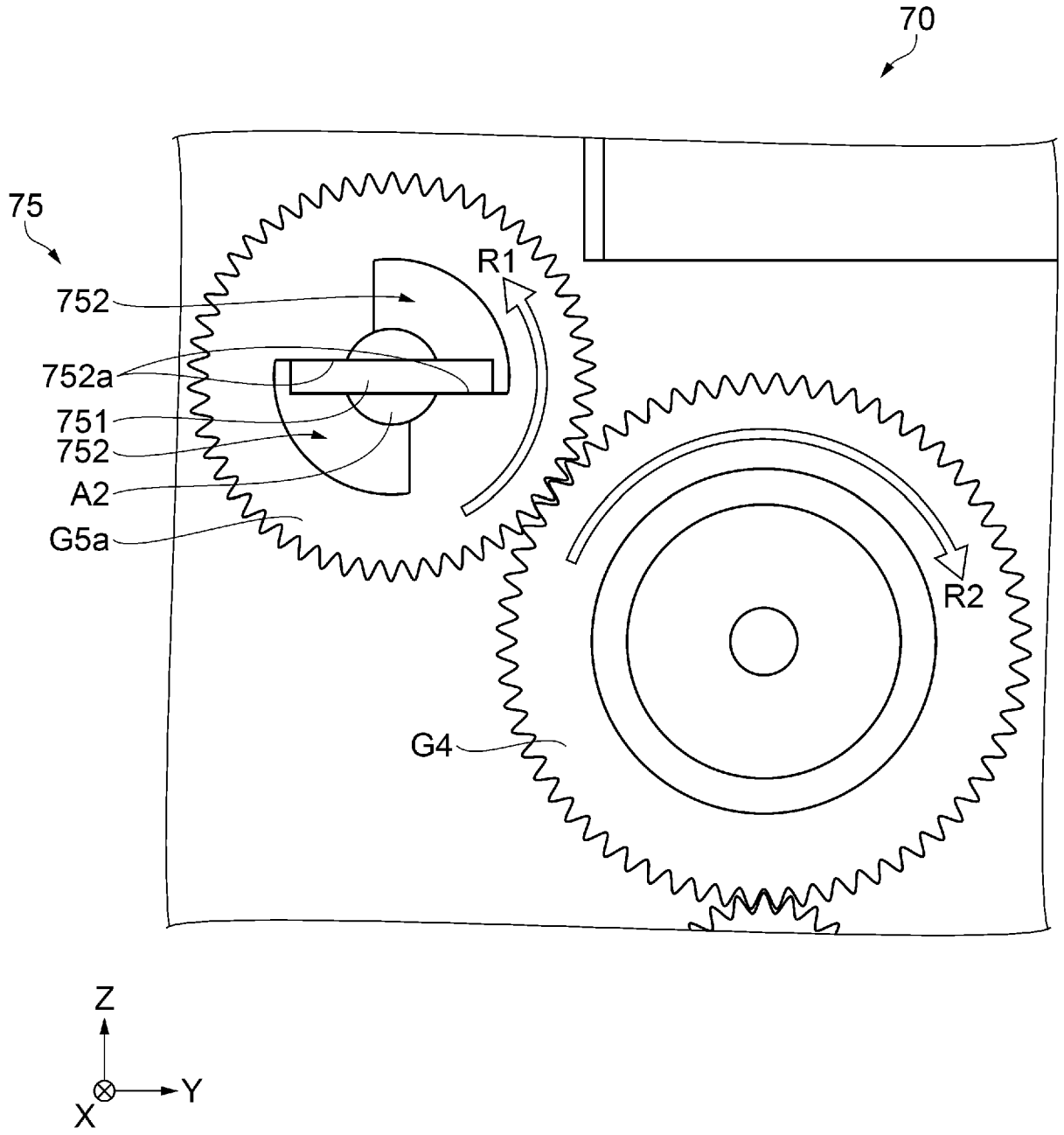
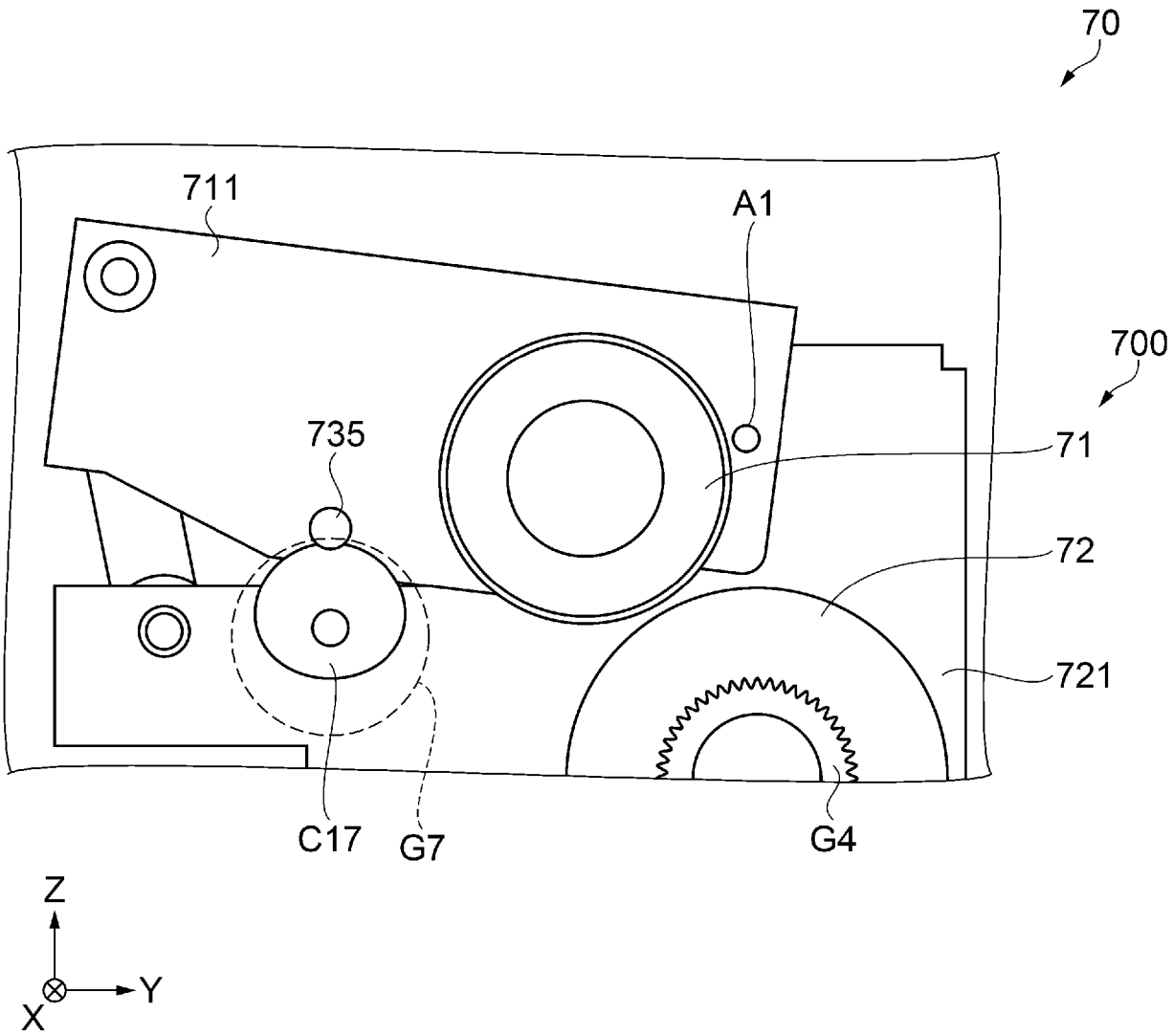


FIG. 15



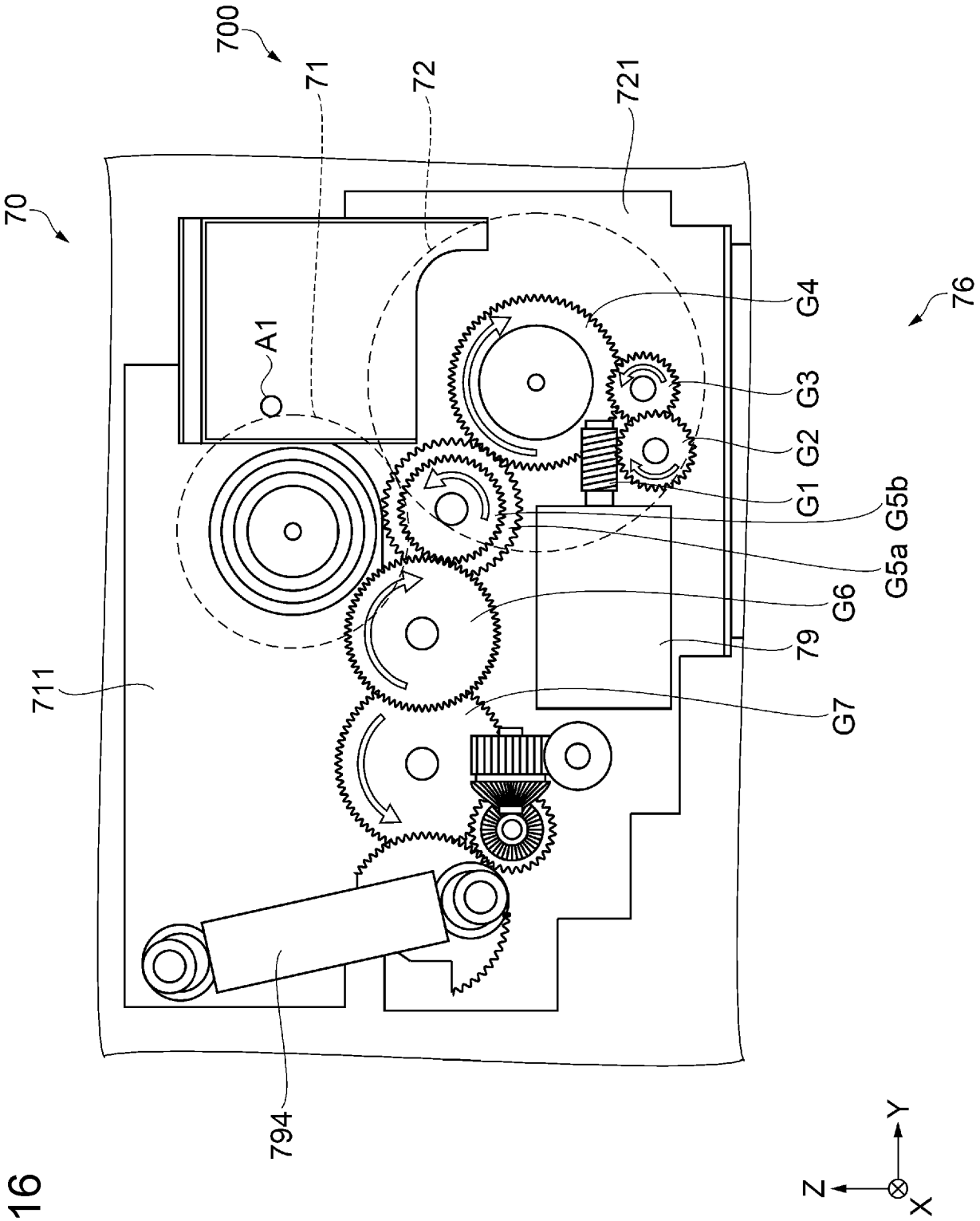
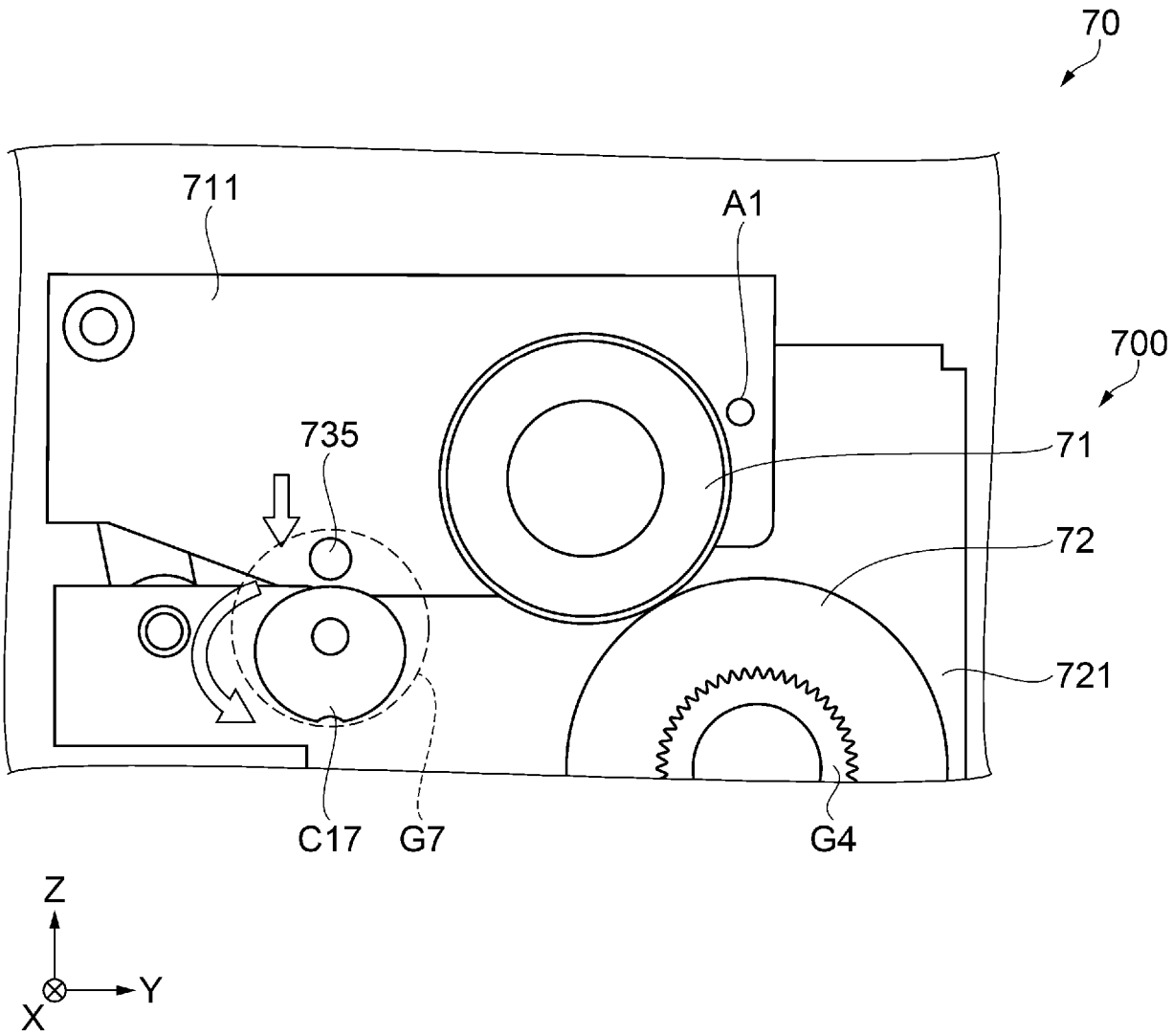


FIG. 16

FIG. 17



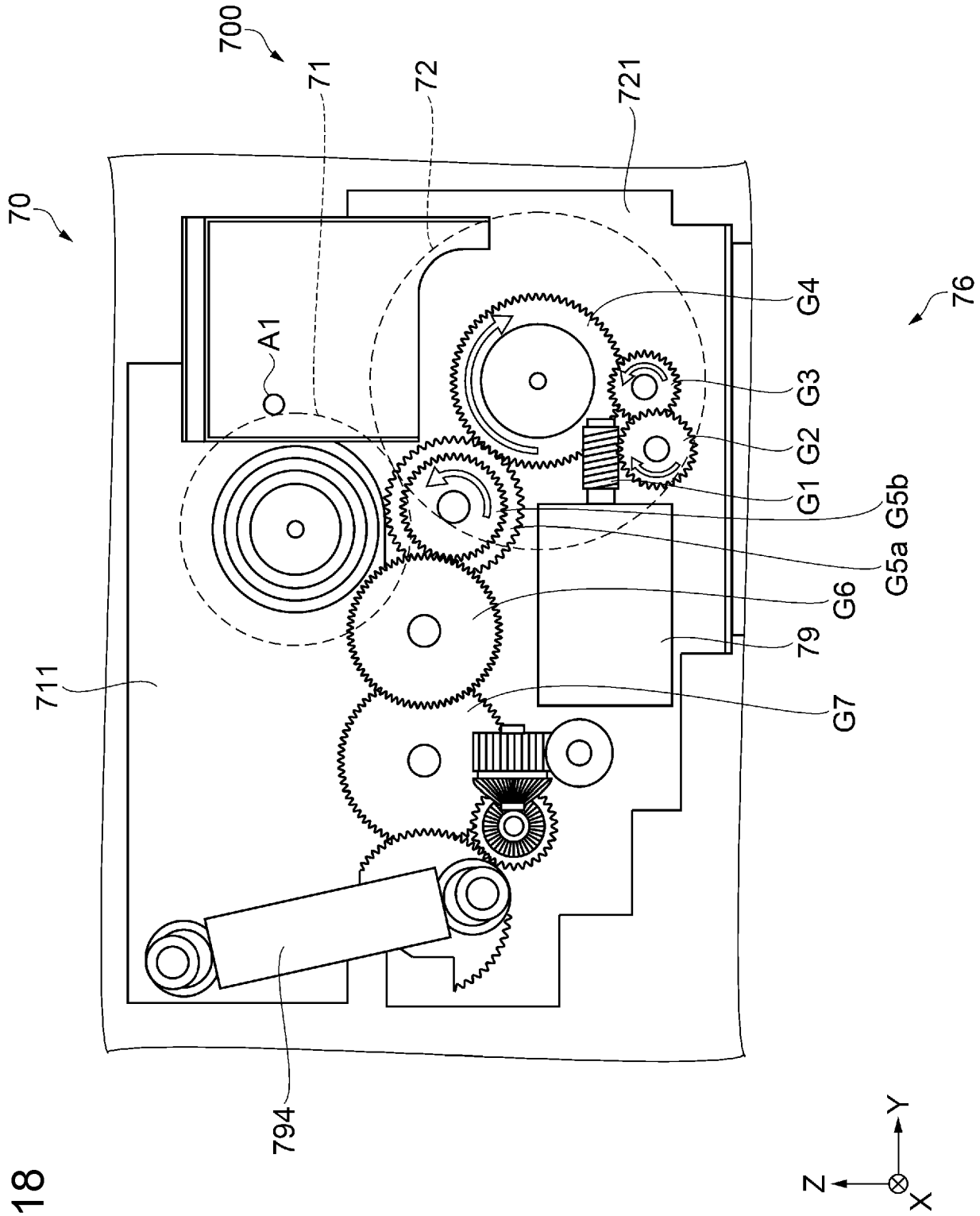


FIG. 18

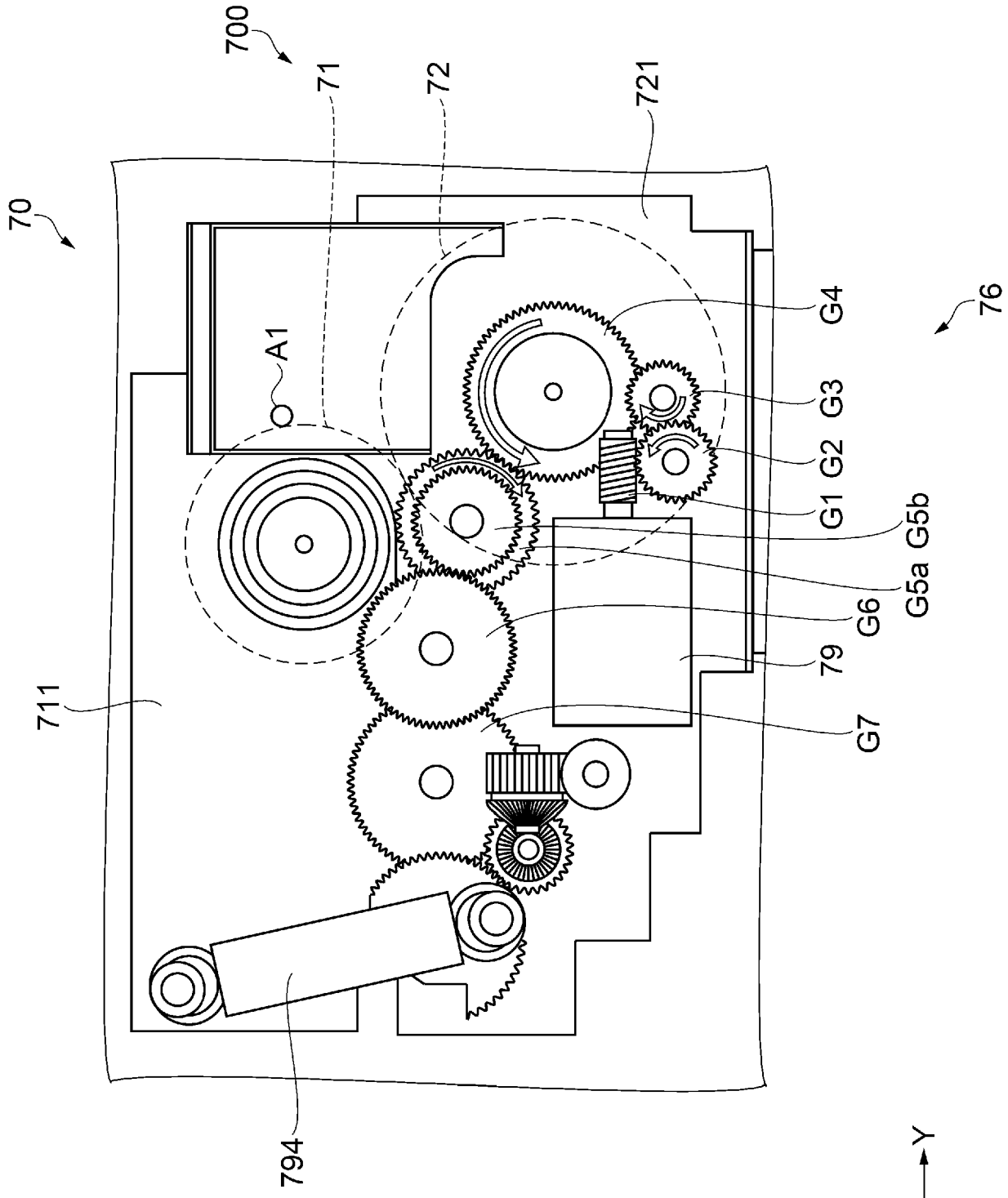


FIG. 19

FIG. 20

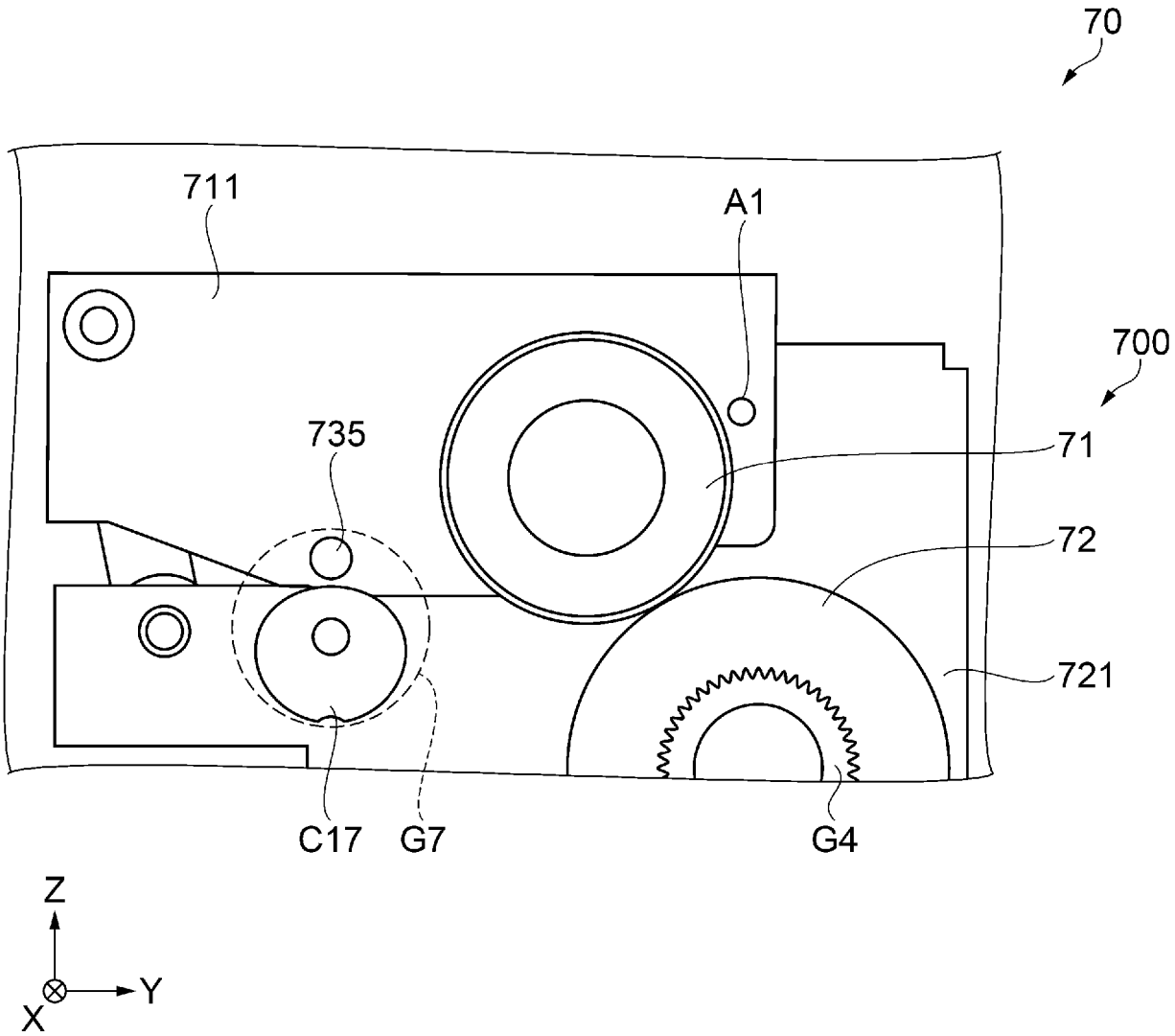


FIG. 21

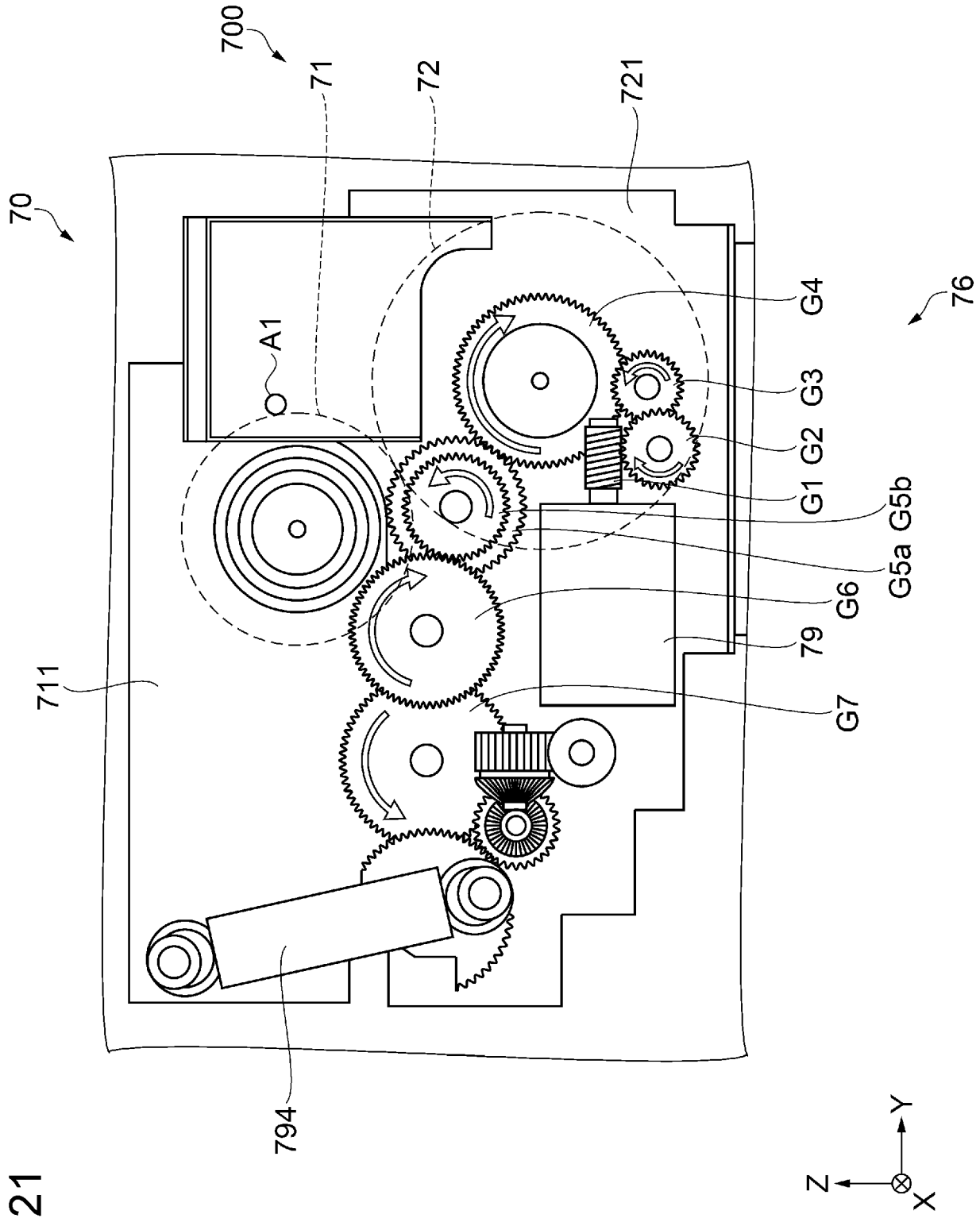
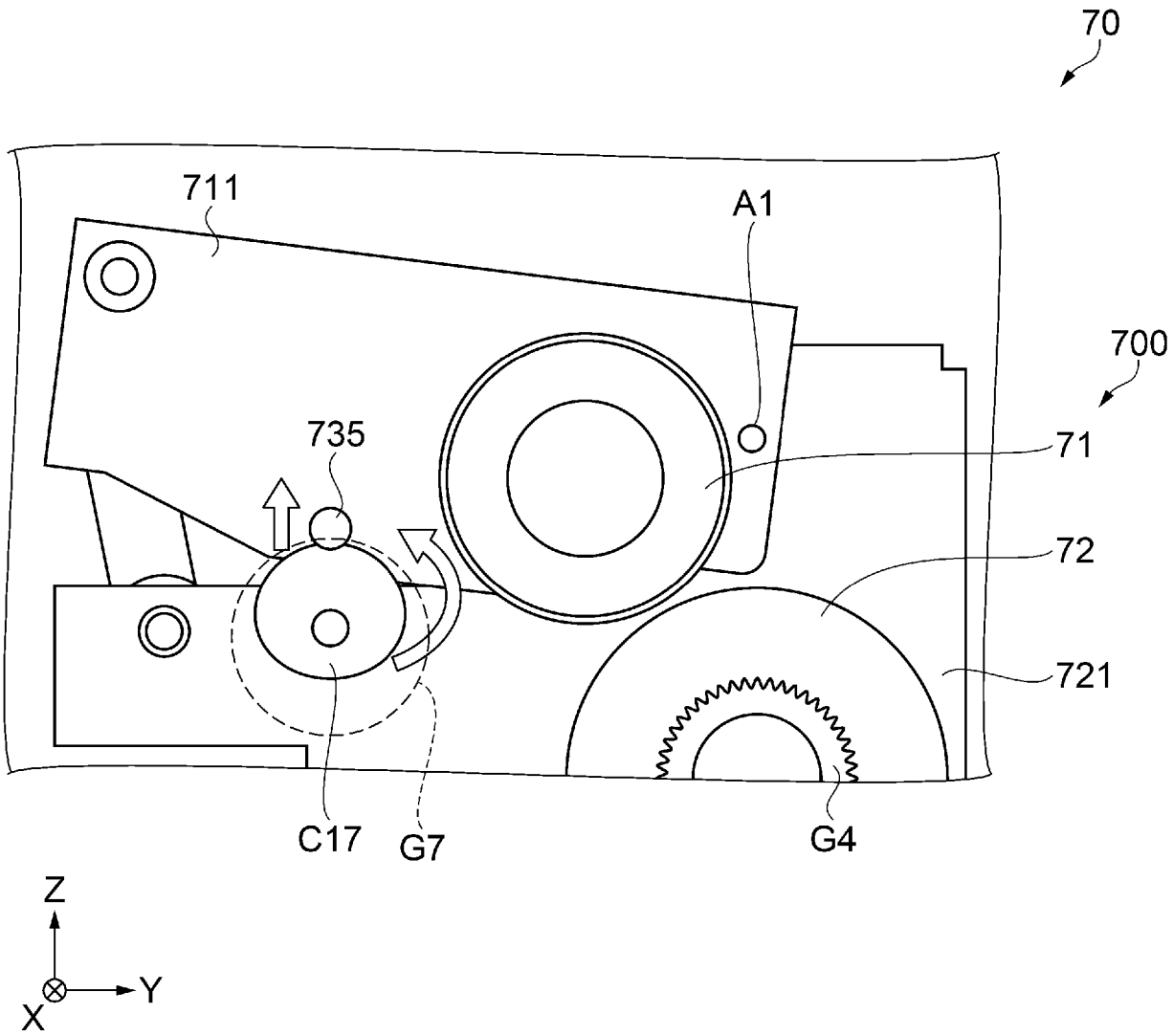


FIG. 22



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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 3816

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 784 211 A1 (SEIKO EPSON CORP [JP]) 1 October 2014 (2014-10-01) * paragraph [0026]; figure 2 *	1-8	INV. D21F9/00 D21G9/00
A	US 2018/319038 A1 (NAGAI YOSHIYUKI [JP] ET AL) 8 November 2018 (2018-11-08) * paragraphs [0004] - [0006], [0100] - [0102]; figures 5A,5b *	1-8	

TECHNICAL FIELDS SEARCHED (IPC)

D21F
D21G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 February 2025	Pregetter, Mario

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17-02-2025

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		US 2018319038 A1	08-11-2018
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Patent documents cited in the description

- JP 2023171148 A **[0001]**
- JP 2014208923 A **[0003] [0004]**