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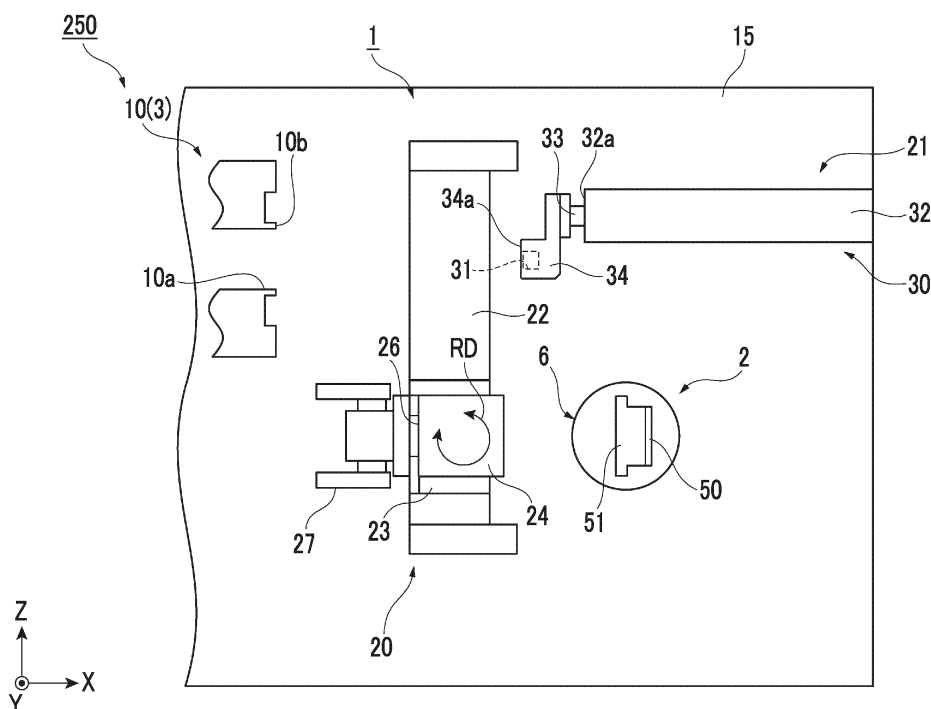
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(54) **CONVEYANCE DEVICE, IRRADIATION SYSTEM, AND IRRADIATION METHOD**

(57) Provided is a conveyance device (1) that can reduce costs and save space. A conveyance portion (20) and an installation portion (21) are separated from each other as different mechanisms. The conveyance portion (20) can adopt a simple configuration required for conveying a target substrate (50), and the installation portion (21) can adopt a simple configuration required for installing the target substrate (50) in an installation unit (3). Each of the conveyance portion (20) and the installation

portion (21) is configured to have a simple structure corresponding to required specifications, which makes it possible to reduce costs. In addition, since the conveyance portion (20) and the installation portion (21) have a simple configuration and are separated from each other, it is possible to dispose the conveyance portion (20) and the installation portion (21) with high flexibility. This makes it possible to save space.

FIG. 3**EP 4 579 687 A1**

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a conveyance device.

Description of Related Art

[0002] A system disclosed in Japanese Unexamined Patent Publication No. 2013-167489 is known as a radioisotope manufacturing system according to the related art. In the radioisotope manufacturing system, a solid target is held at a position of an irradiation port for a particle beam by a target device.

SUMMARY OF THE INVENTION

[0003] Here, in the radioisotope manufacturing system, a conveyance mechanism that conveys the target substrate to the irradiation port and installs the target substrate in the irradiation port may be provided. Here, when the conveyance mechanism installs the target substrate in the irradiation port, a predetermined pressing force is required, and a large pressing structure is required. In addition, when the conveyance mechanism takes out the target substrate transported by a transport unit and conveys the target substrate to the irradiation port using a turning operation or the like, the conveyance mechanism is required to have strength against a large radial load. When the conveyance mechanism attempts to satisfy the requirements of the pressing structure and the strength requirements, there is a problem in that the structure is complicated and increases in size, resulting in an increase in costs and an increase in installation space.

[0004] An aspect of the present invention has been made to solve the above problem, and an object of the present invention is to provide a conveyance device that can reduce costs and save space.

[0005] According to an aspect of the present invention, there is provided a conveyance device that conveys a target substrate between processes related to manufacturing of a radioisotope. The conveyance device includes: a conveyance portion that conveys the target substrate from a position of a transport unit that transports the target substrate to a position of an installation unit that installs the target substrate; and an installation portion that installs the target substrate in the installation unit. The conveyance portion and the installation portion are separated from each other as different mechanisms.

[0006] The conveyance device includes the conveyance portion that conveys the target substrate from the position of the transport unit that transports the target substrate to the position of the installation unit that installs the target substrate and the installation portion that installs the target substrate in the installation unit. Here, the

conveyance portion and the installation portion are separated from each other as different mechanisms. Therefore, the conveyance portion can adopt a simple configuration required for conveying the target substrate, and the installation portion can adopt a simple configuration required for installing the target substrate in the installation unit. As described above, each of the conveyance portion and the installation portion is configured to have a simple structure corresponding to the required specifications, which makes it possible to reduce costs. In addition, since the conveyance portion and the installation portion have a simple configuration and are separated from each other, it is possible to dispose the conveyance portion and the installation portion with high flexibility. Therefore, it is possible to save space. From the above, it is possible to reduce costs and to save space.

[0007] The installation portion may press the target substrate against the installation unit in a first direction, and a position where the conveyance portion takes out the target substrate from the transport unit may be separated from the installation portion in a second direction intersecting the first direction. As described above, the position where the conveyance portion takes out the target substrate deviates from the installation portion. Therefore, when the leakage of cooling water occurs in the installation portion, it is possible to suppress the entrance of the water into the transport unit.

[0008] The installation portion may include a pressing mechanism that presses the target substrate against the installation unit to install the target substrate in the installation unit, and the pressing mechanism may be provided as a mechanism, which is separated from the conveyance portion, in the installation portion. In this case, the pressing mechanism can have an appropriate configuration corresponding to the required specifications without considering a conveyance function.

[0009] The conveyance portion may include a turning mechanism that turns the target substrate which is being conveyed. When a turning function is provided in the installation portion, a turning radius is large, and an excessive radial load is applied to the installation portion. As a result, it is necessary to unnecessarily increase strength. For this reason, the conveyance portion and the installation portion are separated from each other, which makes it possible to suppress an unnecessarily increase in the strength of the installation portion.

[0010] According to another aspect of the present invention, there is provided an irradiation system including the above-described conveyance device and an irradiator that irradiates the target substrate installed in the installation unit with a particle beam.

[0011] According to still another aspect of the present invention, there is provided an irradiation method for irradiating the target substrate installed in the installation unit with a particle beam, using the above-described conveyance device.

[0012] According to the irradiation system and the irradiation method, it is possible to obtain the same

operation and effects as those of the above-described conveyance device.

[0013] According to an aspect of the present invention, it is possible to provide a conveyance device that can reduce costs and save space.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a block diagram showing an RI manufacturing system including a conveyance device according to an embodiment of the present invention.

Figs. 2A and 2B are views showing a target substrate held by a holder.

Fig. 3 is a view showing an irradiation system as viewed from a positive side to a negative side in a Y-axis direction.

Fig. 4 is a view showing the irradiation system as viewed from a negative side to a positive side in a Z-axis direction.

Fig. 5 is a view showing an operation of the conveyance device.

Fig. 6 is a view showing the operation of the conveyance device.

Fig. 7 is a view showing the operation of the conveyance device.

Fig. 8 is a view showing an irradiation system according to a comparative example.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Hereinafter, preferred embodiments of the present invention will be described with reference to the drawings. In addition, in each drawing, the same or equivalent portions are denoted by the same reference numerals, and a duplicate description thereof will be omitted.

[0016] Fig. 1 is a block diagram showing an RI manufacturing system 200 including a conveyance device 1 according to the present embodiment. Figs. 2A and 2B are views showing a target substrate 50 held by a holder 51. The RI manufacturing system 200 is a system for manufacturing and refining a radioisotope (RI) using the target substrate 50. The RI manufacturing system 200 performs a predetermined process between processes related to the manufacturing of the RI, using the conveyance device 1 that conveys the target substrate 50.

[0017] First, the target substrate 50 will be described with reference to Figs. 2A and 2B. The target substrate 50 is a member that has a layer of a target material 52 formed on a surface. In the present embodiment, the target substrate 50 is a plate material having an elliptical shape. However, the shape of the target substrate 50 is not particularly limited. A material that does not dissolve in a solution is adopted as a material forming the target substrate 50. For example, Au or Pt may be adopted. The target material 52 is, for example, bismuth. ²¹¹At is given

as an example of the RI that is generated corresponding to the target material 52. In addition, the target material 52 and the purified RI are not particularly limited, and other RIs may be generated. The target material 52 is formed in a layer shape at a central position of one main surface of the target substrate 50 by plating or the like. The RI is generated by irradiating the target material 52 with a particle beam. Further, particles of the particle beam to be emitted are, for example, protons, deuterons, alpha particles, or ³He. The holder 51 is a member for holding the target substrate 50. The holder 51 has an elliptical shape similarly to the target substrate 50 and is configured as a plate material that has a larger thickness than the target substrate 50. The target substrate 50 is processed in a state of being held by the holder 51 and is processed in a state of being removed from the holder 51 according to each process.

[0018] As shown in Fig. 1, the RI manufacturing system 200 includes a plating apparatus 201, an RI manufacturing apparatus 202, and an RI refining apparatus 203.

[0019] The plating apparatus 201 is an apparatus that forms the target material 52 on the target substrate 50 using a plating process. The target substrate 50 subjected to the plating process by the plating apparatus 201 is transported to the RI manufacturing apparatus 202 while being held by the holder 51. In addition, after the target material 52 is dissolved in the RI refining apparatus 203, the target material 52 is formed on the target substrate 50, which makes it possible to manufacture the RI with the RI manufacturing apparatus 202 again.

[0020] The RI manufacturing apparatus 202 is an apparatus that manufactures the RI using the target substrate 50. The RI manufacturing apparatus 202 is configured by, for example, an accelerator (cyclotron) having an irradiation port for the particle beam. In the RI manufacturing apparatus 202, the target substrate 50 held by the holder 51 is installed in the irradiation port. The RI manufacturing apparatus 202 irradiates the target material 52 of the target substrate 50 installed in the irradiation port with the particle beam. Then, the RI is generated in a portion, which has been irradiated with the particle beam, in the target material 52. In addition, the RI manufacturing apparatus 202 has the conveyance device 1 that conveys the transported target substrate 50 to the irradiation port. The conveyance device 1 will be described in detail below.

[0021] The RI refining apparatus 203 is an apparatus that refines and extracts the RI from the target substrate 50 irradiated with the particle beam. The RI refining apparatus 203 dissolves the target material 52 including the RI of the target material 52. The RI refining apparatus 203 puts the target substrate 50 removed from the holder 51 in a tank to dissolve the target material 52. The RI refining apparatus 203 extracts the RI from the solution to refine a high-purity RI.

[0022] Next, an irradiation system 250 and the conveyance device 1 according to the present embodiment will be described in detail with reference to Figs. 3 and 4.

For convenience of explanation, an XYZ coordinate system is set for description. A Y-axis direction is a direction perpendicular to an X-axis direction. A Z-axis direction is a direction perpendicular to the X-axis direction and the Y-axis direction. Fig. 3 is a view showing the irradiation system 250 as viewed from a positive side to a negative side in the Y-axis direction. Fig. 4 is a view showing the irradiation system 250 as viewed from a negative side to a positive side in the Z-axis direction. As shown in Figs. 3 and 4, the irradiation system 250 includes the conveyance device 1, a transport unit 2, and an installation unit 3.

[0023] The transport unit 2 is a unit that transports the target substrate 50 from another location to the vicinity of the installation unit 3. As shown in Fig. 4, the transport unit 2 includes a pneumatic tube 4, an end position 6, and a direction correction unit 7. The transport unit 2 transports the target substrate 50 in a state in which the holder 51 holding the target substrate 50 is fixed to a pneumatic capsule 8. The pneumatic tube 4 is a tubular member that transports the pneumatic capsule 8 accommodated therein using the force of gas. The pneumatic tube 4 extends from a position where a previous process (for example, the plating process in the plating apparatus 201) has been performed to the position of the conveyance device 1. In the range shown in Fig. 4, the pneumatic tube 4 extends from the negative side to the positive side in the Y-axis direction. The end position 6 is provided in a tip portion of the pneumatic tube 4. At the end position 6, the target substrate 50 fixed to the pneumatic capsule 8 can be taken out together with the holder 51. The direction correction unit 7 corrects the direction of the target substrate 50 at the end position 6. The posture of the target substrate 50 is rotated while the target substrate 50 is being pneumatically transported through the pneumatic tube 4. Therefore, the direction correction unit 7 corrects the direction of the target substrate 50 such that the conveyance device 1 can easily hold the target substrate 50 at the end position 6. As a result, the direction of the target substrate 50 is corrected such that an opening portion 8a of the pneumatic capsule 8 is opened toward the negative side in the X-axis direction. Therefore, the conveyance device 1 can take out the target substrate 50 at the end position 6 from the positive side to the negative side in the X-axis direction.

[0024] The installation unit 3 is a unit for installing the target substrate 50. As shown in Fig. 4, in the present embodiment, the installation unit 3 is configured by an irradiation port 10 (irradiator) for irradiating the installed target substrate 50 with a particle beam B. The irradiation port 10 is disposed at a position that is separated from the end position 6 of the transport unit 2 to the negative side in the X-axis direction and to the positive side in the Z-axis direction (see Fig. 3). In addition, an opening portion 10a of the irradiation port 10 is formed to be open toward the positive side in the X-axis direction. An internal space SP of the irradiation port 10 is expanded toward the positive side in the Y-axis direction. The particle beam B is emitted from the positive side to the negative side in the Y-axis

direction in the internal space SP. The target substrate 50 is exposed to the internal space SP in a state in which the target substrate 50 is installed at the position of the opening portion 10a of the irradiation port 10. Therefore, the target substrate 50 is irradiated with the particle beam B. In addition, in order to perform the irradiation, the target substrate 50 is slightly inclined with respect to the Y-axis direction such that it is inclined toward the positive side in the X-axis direction as it extends toward the positive side in the Y-axis direction. Therefore, the end position 6 of the transport unit 2 and the conveyance device 1 are also slightly inclined with respect to the Y-axis direction according to the inclination. In an end surface of the irradiation port 10 on the positive side in the X-axis direction, the vicinity of the opening portion 10a is configured as an installation surface 10b of the holder 51 of the target substrate 50 (see also Fig. 3).

[0025] Next, the conveyance device 1 will be described. The conveyance device 1 is a conveyance device that conveys the target substrate 50 between the processes related to the manufacturing of the radioisotope. In the present embodiment, the conveyance device 1 conveys the target substrate 50 between an RI manufacturing process in the RI manufacturing apparatus 202 and the previous process (for example, the plating process in the plating apparatus 201) of the RI manufacturing. The conveyance device 1 includes a conveyance portion 20 and an installation portion 21. The conveyance portion 20 and the installation portion 21 are separated from each other as different mechanisms. That is, the conveyance portion 20 and the installation portion 21 are configured by separate components and are provided at different positions. In addition, the conveyance portion 20 and the installation portion 21 are provided on a plate-shaped base member 15 that extends in the XZ direction (see Fig. 4).

[0026] As shown in Fig. 3, the conveyance portion 20 conveys the target substrate 50 together with the holder 51 from the end position 6 of the transport unit 2 to the position of the installation surface 10b of the irradiation port 10 of the installation unit 3. The conveyance portion 20 includes a Z-axis guide portion 22, a slider portion 23, a support portion 24, an arm portion 26, and a chuck portion 27. The Z-axis guide portion 22 is a member that guides the slider portion 23 in the Z-axis direction. The Z-axis guide portion 22 is disposed at a position between the end position 6 of the transport unit 2 and the irradiation port 10 of the installation unit 3 in the X-axis direction. The Z-axis guide portion 22 extends in the Z-axis direction, extends to the negative side in the Z-axis direction beyond the end position 6 of the transport unit 2, and extends to the positive side in the Z-axis direction beyond the installation surface 10b of the irradiation port 10.

[0027] The slider portion 23 is a member that reciprocates in the Z-axis direction along the Z-axis guide portion 22. The support portion 24, the arm portion 26, and the chuck portion 27 are provided above the slider portion 23. These members are moved with the movement of the

slider portion 23. The support portion 24 is connected to an upper surface of the slider portion 23 and supports the chuck portion 27 through the arm portion 26. The arm portion 26 is a member that extends from the support portion 24 to one side in the X-axis direction (the negative side in the X-axis direction in Fig. 3). The arm portion 26 can be extended and contracted to move the chuck portion 27 in the X-axis direction with respect to the support portion 24. The chuck portion 27 is a member that is provided at a tip of the arm portion 25 and is a member that can hold the target substrate 50 through the holder 51. The chuck portion 27 pinches the holder 51 from both sides to hold the holder 51.

[0028] The conveyance portion 20 has a turning mechanism 29 that turns the target substrate 50 which is being conveyed (see Fig. 4). The turning mechanism 29 is provided between the slider portion 23 and the support portion 24. The turning mechanism 29 turns the support portion 24, the arm portion 26, and the chuck portion 27 in a turning direction RD when viewed from the Y-axis direction (in the direction shown in Fig. 3). Therefore, the conveyance portion 20 can turn the target substrate 50 (see Fig. 5) held by the chuck portion 27 on the positive side in the X-axis direction with respect to the Z-axis guide portion 22 to move the target substrate 50 to the negative side in the X-axis direction with respect to the Z-axis guide portion 22 (see Fig. 6).

[0029] The installation portion 21 installs the target substrate 50 in the installation unit 3. The installation portion 21 is disposed at a position that is separated from the Z-axis guide portion 22 of the conveyance portion 20 to the positive side in the X-axis direction and is disposed at a position that is separated from the end position 6 of the transport unit 2 to the positive side in the Z-axis direction. In addition, the installation portion 21 is disposed at a position that is separated from the installation surface 10b of the irradiation port 10 to the positive side in the X-axis direction to face the installation surface 10b. The installation portion 21 includes a pressing mechanism 30 and a cooling mechanism 31.

[0030] The pressing mechanism 30 is a mechanism that presses the target substrate 50 against the irradiation port 10 of the installation unit 3 to install the target substrate 50 in the irradiation port 10. The pressing mechanism 30 is a mechanism that is provided as a mechanism, which is separated from the conveyance portion 20, in the installation portion 21. That is, the pressing mechanism 30 is formed by a constituting member that is separated from each constituting member of the conveyance portion 20. The pressing mechanism 30 includes a cylinder portion 32, a rod portion 33, and a pressing portion 34.

[0031] The cylinder portion 32 is a member that supports the rod portion 33 such that the rod portion 33 can be advanced and retreated. The cylinder portion 32 is a member that extends in the X-axis direction. The rod portion 33 is a rod-shaped member that protrudes from an end portion 32a of the cylinder portion 32 on the

negative side in the X-axis direction. The rod portion 33 reciprocates in the cylinder portion 32 such that the amount of protrusion of the rod portion 33 from the end portion 32a of the cylinder portion 32 is expanded and contracted. The pressing portion 34 presses the holder 51 of the target substrate 50 against the installation surface 10b of the irradiation port 10. The pressing portion 34 is provided in an end portion of the rod portion 33 on the negative side in the X-axis direction. Therefore, when the amount of protrusion of the rod portion 33 from the end portion 32a is increased, the pressing portion 34 is moved to the negative side in the X-axis direction and extends to the vicinity of the installation surface 10b of the irradiation port 10. Therefore, the pressing portion 34 can press the target substrate 50 against the irradiation port 10 (see Fig. 7). When the amount of protrusion from the end portion 32a of the rod portion 33 is decreased, the pressing portion 34 is moved to the positive side in the X-axis direction (see Figs. 5 and 6). A pressing surface 34a that presses the holder 51 is formed at an end of the pressing portion 34 on the negative side in the X-axis direction. In addition, the pressing portion 34 is disposed on the positive side in the Y-axis direction with respect to the Z-axis guide portion 22. Therefore, even when the pressing portion 34 extends to the irradiation port 10, the pressing portion 34 can avoid interference with the Z-axis guide portion 22.

[0032] The cooling mechanism 31 is a mechanism that cools the target substrate 50 installed in the irradiation port 10. The cooling mechanism 31 is configured by a flow path of a cooling medium formed in the pressing surface 34a. The cooling medium flows through the flow path of the cooling mechanism 31 between an inlet portion and an outlet portion (not shown). Therefore, the holder 51 pressed by the pressing surface 34a is cooled. As a result, it is possible to cool the target substrate 50 through the holder 51.

[0033] According to the above-described structure, the installation portion 21 presses the target substrate 50 against the installation unit 3 in the X-axis direction (first direction). A position (end position 6) where the conveyance portion 20 takes out the target substrate 50 from the transport unit 2 is separated from the installation portion 21 in the Z-axis direction perpendicular to the X-axis direction. The position (end position 6) where the conveyance portion 20 takes out the target substrate 50 from the transport unit 2 is disposed to deviate from the installation portion 21 and the irradiation port 10 to the negative side in the Z-axis direction.

[0034] Next, the operation of the conveyance device 1 will be described with reference to Figs. 5 to 7. Fig. 5 shows a state in which the target substrate 50 reaches the end position 6 of the transport unit 2. In this case, the conveyance portion 20 of the conveyance device 1 moves the chuck portion 27 to a position corresponding to the end position 6 in the Z-axis direction. In addition, the conveyance portion 20 turns the chuck portion 27 to the positive side in the X-axis direction with respect to the Z-

axis guide portion 22. Then, the conveyance portion 20 moves the chuck portion 27 to the positive side in the X-axis direction to hold the holder 51 at the end position 6. After holding the holder 51 with the chuck portion 27 at the end position 6, the conveyance portion 20 moves the chuck portion 27 to the negative side in the X-axis direction to take out the target substrate 50 together with the holder 51 from the end position 6. Then, the conveyance portion 20 turns the chuck portion 27 and the target substrate 50. Then, the conveyance portion 20 moves the chuck portion 27 and the target substrate 50 to the negative side in the X-axis direction with respect to the Z-axis guide portion 22. In this case, the chuck portion 27 is disposed at the position shown in Fig. 3.

[0035] Then, the conveyance portion 20 moves the chuck portion 27 holding the target substrate 50 to the positive side in the Z-axis direction and moves the target substrate 50 to the front side of the installation surface 10b of the irradiation port 10. The conveyance portion 20 moves the target substrate 50 held by the chuck portion 27 together with the holder 51 to the negative side in the X-axis direction. Therefore, the conveyance portion 20 can temporarily place the target substrate 50 in the irradiation port 10 as shown in Fig. 6. In this case, a flange portion of the holder 51 is disposed to come into contact with the installation surface 10b. After temporarily placing the target substrate 50 in the irradiation port 10, the conveyance portion 20 returns to the original state (the state of the conveyance portion 20 shown in Figs. 3 and 7).

[0036] Then, the installation portion 21 moves the pressing portion 34 to the negative side in the X-axis direction to press the holder 51 against the installation surface 10b. Therefore, as shown in Fig. 7, the installation portion 21 completes the state in which the target substrate 50 is installed in the irradiation port 10. In addition, the installation portion 21 cools the target substrate 50 through the holder 51 with the cooling mechanism 31. In this state, in the irradiation port 10, the target substrate 50 is irradiated with the particle beam B (see Fig. 4). In addition, the conveyance portion 20 collects the target substrate 50 completely irradiated with the particle beam B and returns the target substrate 50 to the transport unit 2. The target substrate 50 is transported to a location for the subsequent process, such as the RI refining apparatus 203, by the transport unit 2.

[0037] Next, the operations and effects of the conveyance device 1, the irradiation system 250, and an irradiation method according to the present embodiment will be described.

[0038] Fig. 8 is a view showing an irradiation system 300 according to a comparative example. In the irradiation system 300 according to the comparative example, a conveyance device 301 has both a conveyance function and an installation function. The conveyance device 301 presses the target substrate 50 to the negative side in the X-axis direction against an irradiation port 302. A pneumatic tube 310 of a transport unit 303 is disposed to

extend in the X-axis direction at a position that is separated from the irradiation port 302 to the negative side in the Y-axis direction. The conveyance device 301 is in a state of extending to the negative side in the Y-axis direction and takes out the target substrate 50 from the end position 311 of the transport unit 303. Then, the conveyance device 301 turns the target substrate 50 in the turning direction RD and installs the target substrate 50 in the irradiation port 302. When the conveyance device 301 installs the target substrate 50 in the irradiation port 302, a pressing force considering a crushing force of an O-ring, a cooling water circulation pressure, the weight of the target substrate 50, and the weight of a pipe is required. As a result, a large pressing structure is required. In addition, the conveyance device 301 takes out the target substrate 50 transported by the transport unit 303 and performs a turning operation. Therefore, the conveyance device 301 is required to have strength against a large radial load. When the conveyance device 301 attempts to satisfy the requirements of the pressing structure and the strength requirements, there is a problem in that the structure is complicated and increases in size, resulting in an increase in costs and an increase in installation space.

[0039] Here, in order to perform the above-described operation of the conveyance device 301, the irradiation port 302 and the end position 311 need to be present at the same position in the Z-axis direction. Here, a cooling structure for cooling the target substrate 50 is present in a pressing portion of the conveyance device 301. Therefore, in a case where the positive side in the Y-axis direction is an upward direction, when water leakage occurs in the cooling structure, there is a possibility that the cooling water W will enter the transport unit 303. When the entrance of the cooling water W occurs, a puddle of water is formed in the pneumatic tube 310 that is difficult to reach. This puddle of water in the pneumatic tube 310 hinders the transport of the target substrate 50, and causes clogging. As a result, the target substrate 50 having a high radiation dose is left in the pneumatic tube 310. In addition, even when the entrance of water is found before the transport, it is not possible to use the transport unit 303. Therefore, the target substrate 50 having a high radiation dose is in a state of being attached to the irradiation port 302. In this case, it is necessary to wait for the attenuation of the radiation dose (the half-life is 7.2 h), and the restoration takes time. For example, when the X-axis direction is set as an up-down direction, it is possible to establish the positional relationship in which water is less likely to enter the transport unit 303, but versatility is reduced.

[0040] In contrast, the conveyance device 1 according to the present embodiment includes the conveyance portion 20 that conveys the target substrate 50 from the position of the transport unit 2 that transports the target substrate 50 to the position of the installation unit 3 that installs the target substrate 50, and the installation portion 21 that installs the target substrate 50 in the

installation unit 3. Here, the conveyance portion 20 and the installation portion 21 are separated from each other as different mechanisms. Therefore, the conveyance portion 20 can adopt a simple configuration required for conveying the target substrate 50, and the installation portion 21 can adopt a simple configuration required for installing the target substrate 50 in the installation unit 3. In the irradiation system 300 according to the comparative example, the conveyance device 301 has both the conveyance function and the installation function. Therefore, each function needs to have excessive specifications, which results in an increase in costs. In contrast, in the present embodiment, each of the conveyance portion 20 and the installation portion 21 is configured to have a simple structure corresponding to the required specifications, which makes it possible to reduce costs. In addition, since the conveyance portion 20 and the installation portion 21 have a simple configuration and are separated from each other, it is possible to dispose the conveyance portion 20 and the installation portion 21 with high flexibility. Therefore, it is possible to save space. From the above, it is possible to reduce costs and to save space.

[0041] The installation portion 21 may press the target substrate 50 against the installation unit 3 in the X-axis direction (first direction), and the position where the conveyance portion 20 takes out the target substrate 50 from the transport unit 2 may be separated from the installation portion 21 in the Z-axis direction (second direction) intersecting the X-axis direction. As described above, the position where the conveyance portion 20 takes out the target substrate 50 is disposed to deviate from the installation portion 21. Therefore, when the leakage of the cooling water occurs in the installation portion 21, it is possible to suppress the entrance of the water into the transport unit 2. In addition, according to this configuration, it is possible to suppress the entrance of the water regardless of the direction of the irradiation port 10 and thus to improve the versatility of the system.

[0042] The installation portion 21 may have the pressing mechanism 30 that presses the target substrate 50 against the installation unit 3 to install the target substrate 50 in the installation unit 3, and the pressing mechanism 30 may be provided as a mechanism, which is separated from the conveyance portion 20, in the installation portion 21. In this case, the pressing mechanism 30 can have an appropriate configuration corresponding to the required specifications without considering the conveyance function.

[0043] The conveyance portion 20 may include the turning mechanism 29 that turns the target substrate 50 which is being conveyed. When the installation portion 21 is configured to have the turning function, a turning radius is large, and an excessive radial load is applied to the installation portion 21. As a result, it is necessary to unnecessarily increase the strength. For this reason, the conveyance portion 20 and the installation portion 21 are separated from each other, which makes it possible to suppress an unnecessary increase in the strength of the

installation portion 21.

[0044] The irradiation system 250 according to the present embodiment includes the conveyance device 1 and the irradiation port 10 (irradiator) that irradiates the target substrate 50 installed in the installation unit 3 with the particle beam.

[0045] The irradiation method according to the present embodiment irradiates the target substrate 50 installed in the installation unit 3 with the particle beam, using the conveyance device 1.

[0046] According to the irradiation system 250 and the irradiation method, it is possible to obtain the same operation and effects as those of the conveyance device 1.

[0047] The present invention is not limited to the above-described embodiment.

[0048] For example, the disposition and configuration of the transport unit 2, the installation unit 3, the conveyance portion 20, and the installation portion 21 according to the above-described embodiment are only examples and can be appropriately changed without departing from the concept of the present invention.

Brief Description of the Reference Symbols

[0049]

- 1: Conveyance device
- 2: Transport unit
- 3: Installation unit
- 20: Conveyance portion
- 21: Installation portion
- 29: Turning mechanism
- 30: Pressing mechanism
- 50: Target substrate
- 250: Irradiation system

Claims

1. A conveyance device (1) that conveys a target substrate (50) between processes related to manufacturing of a radioisotope, the conveyance device (1) comprising:

a conveyance portion (20) that conveys the target substrate (50) from a position of a transport unit (2) that transports the target substrate (50) to a position of an installation unit (3) that installs the target substrate (50); and an installation portion (21) that installs the target substrate (50) in the installation unit (3), wherein the conveyance portion (20) and the installation portion (21) are separated from each other as different mechanisms.

2. The conveyance device (1) according to claim 1,

wherein the installation portion (21) presses the target substrate (50) against the installation unit (3) in a first direction, and
a position where the conveyance portion (20) takes out the target substrate (50) from the transport unit (2) is separated from the installation portion (21) in a second direction intersecting the first direction.

3. The conveyance device (1) according to claim 1, 10

wherein the installation portion (21) includes a pressing mechanism (30) that presses the target substrate (50) against the installation unit (3) to install the target substrate (50) in the installation unit (3), and
the pressing mechanism (30) is provided as a mechanism, which is separated from the conveyance portion (20), in the installation portion (21). 15 20

4. The conveyance device (1) according to claim 1, wherein the conveyance portion (20) includes a turning mechanism (29) that turns the target substrate (50) which is being conveyed. 25

5. An irradiation system (250) comprising:

the conveyance device (1) according to any one of claims 1 to 4; and
an irradiator that irradiates the target substrate (50) installed in the installation unit (3) with a particle beam (B). 30

6. An irradiation method for irradiating the target substrate (50) installed in the installation unit (3) with a particle beam (B), using the conveyance device (1) according to any one of claims 1 to 4. 35

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FIG. 1

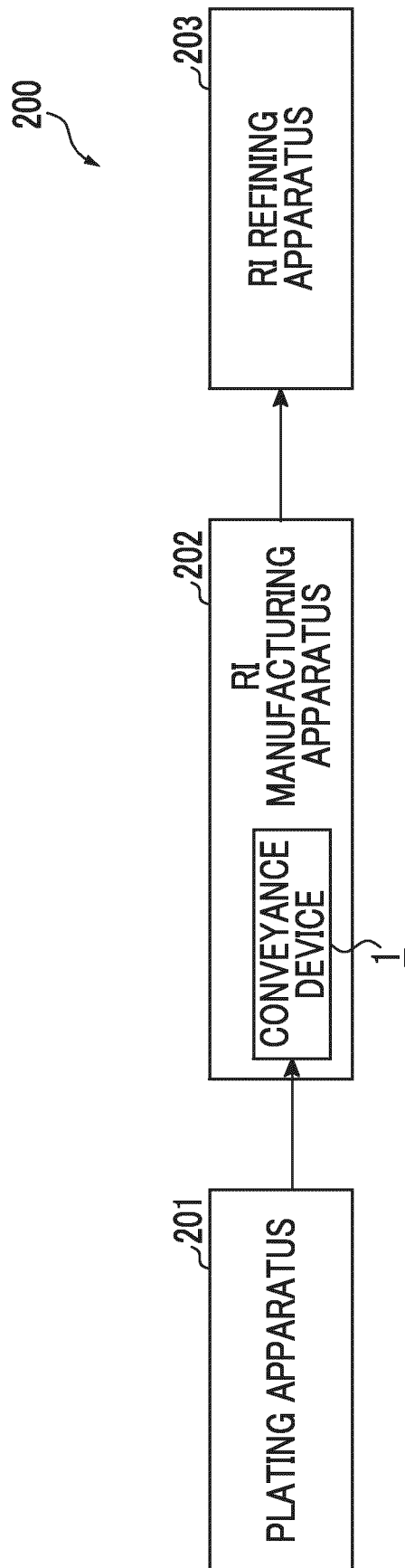


FIG. 2A

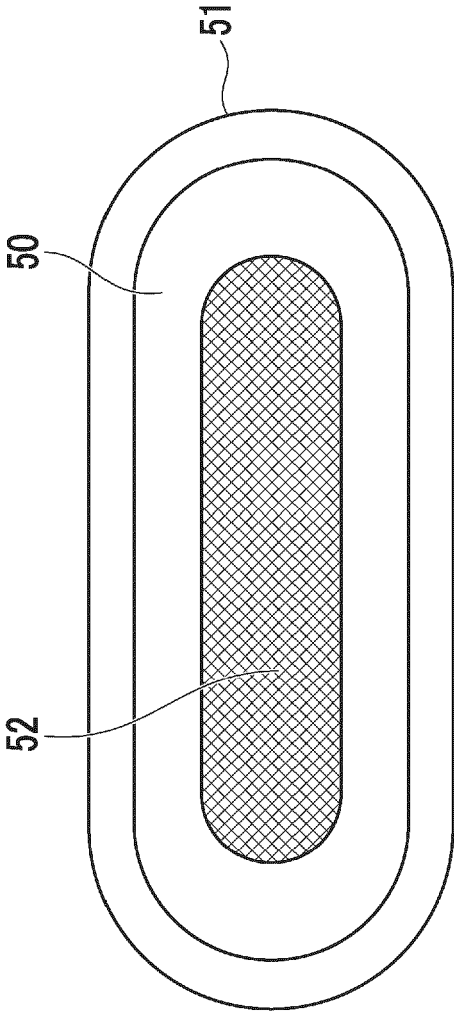


FIG. 2B

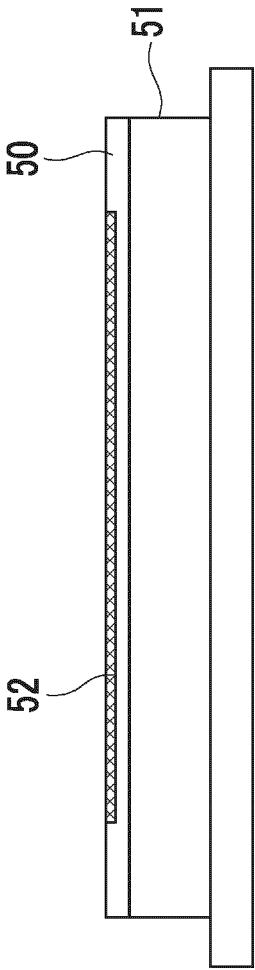


FIG. 3

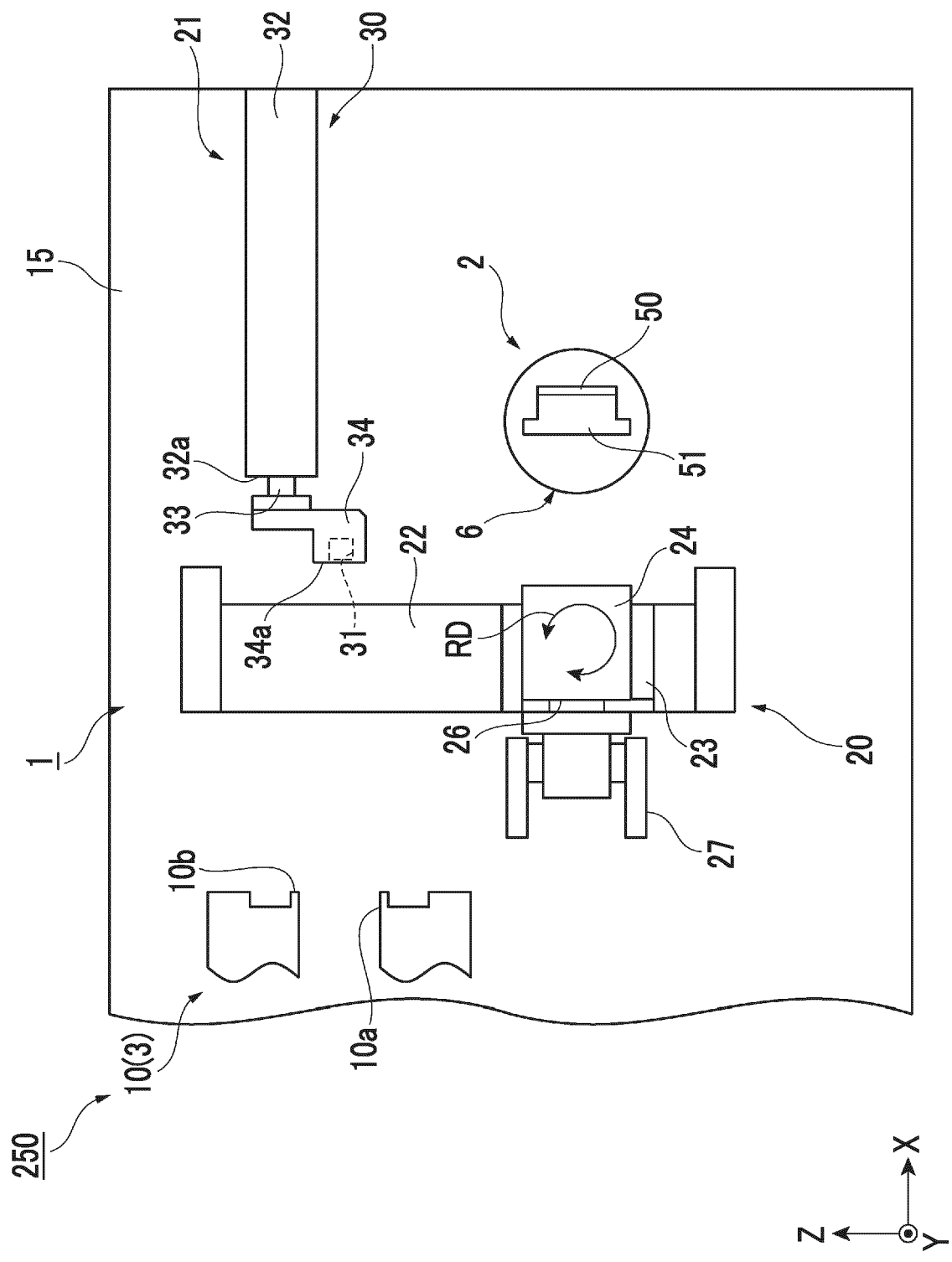


FIG. 4

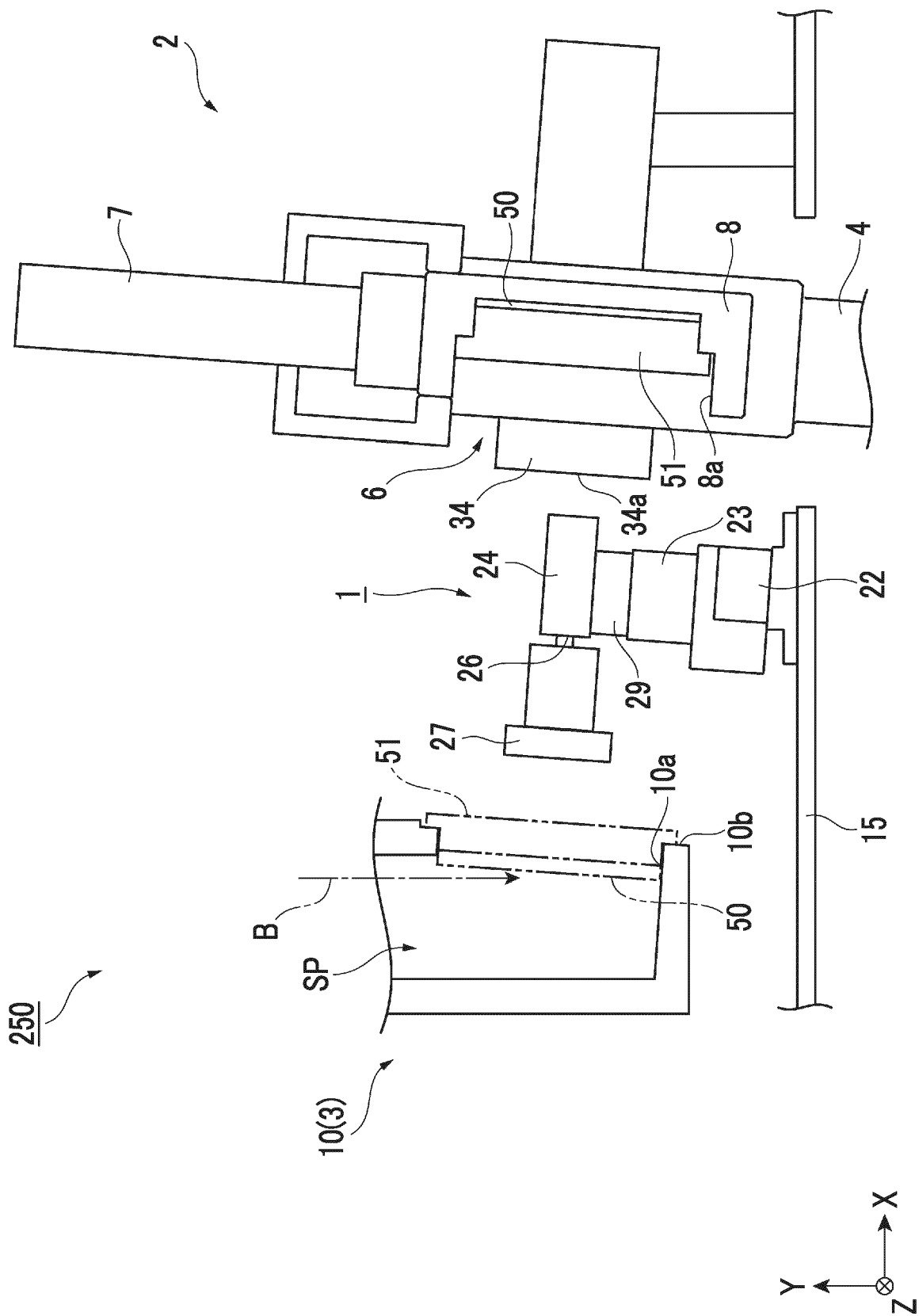


FIG. 5

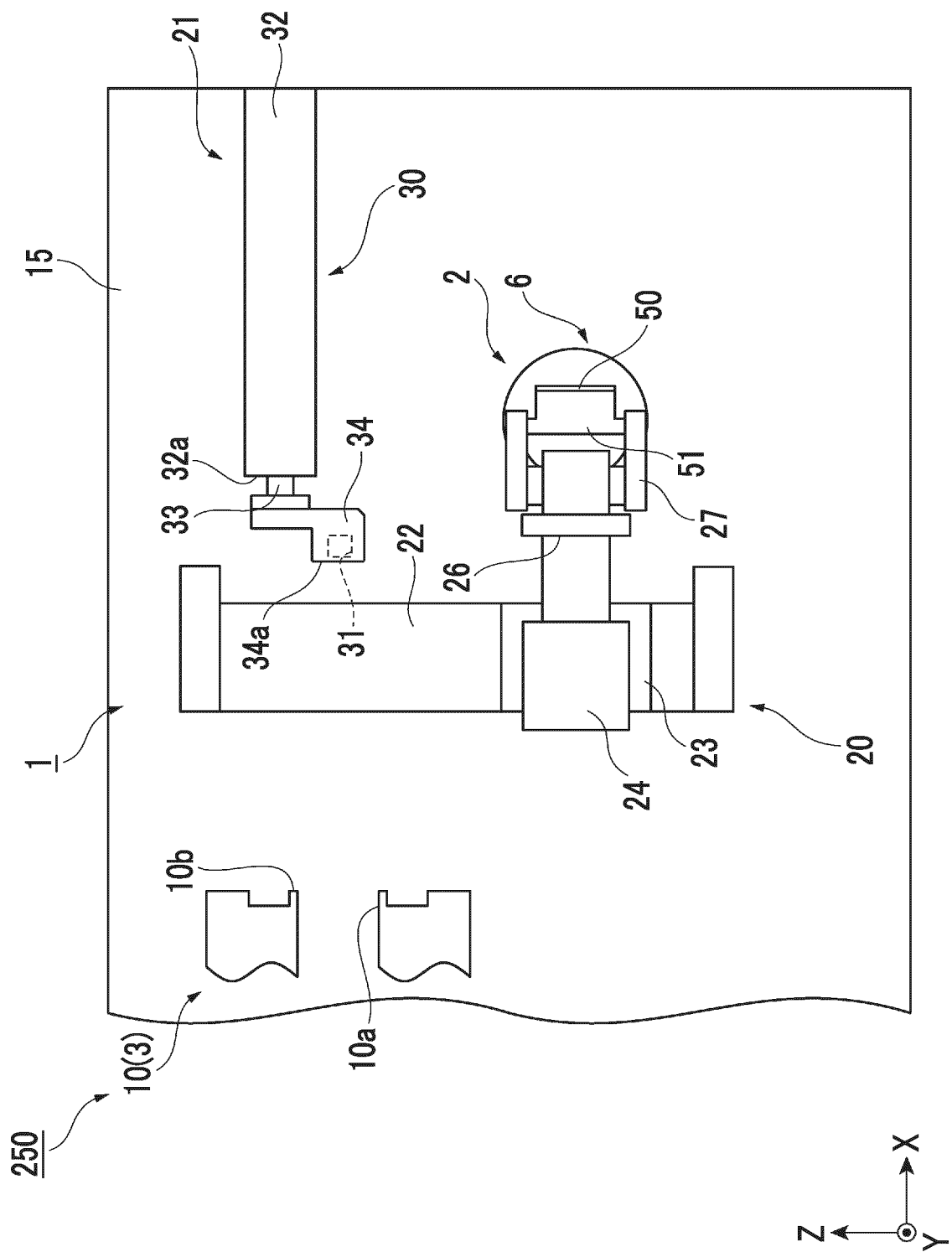


FIG. 6

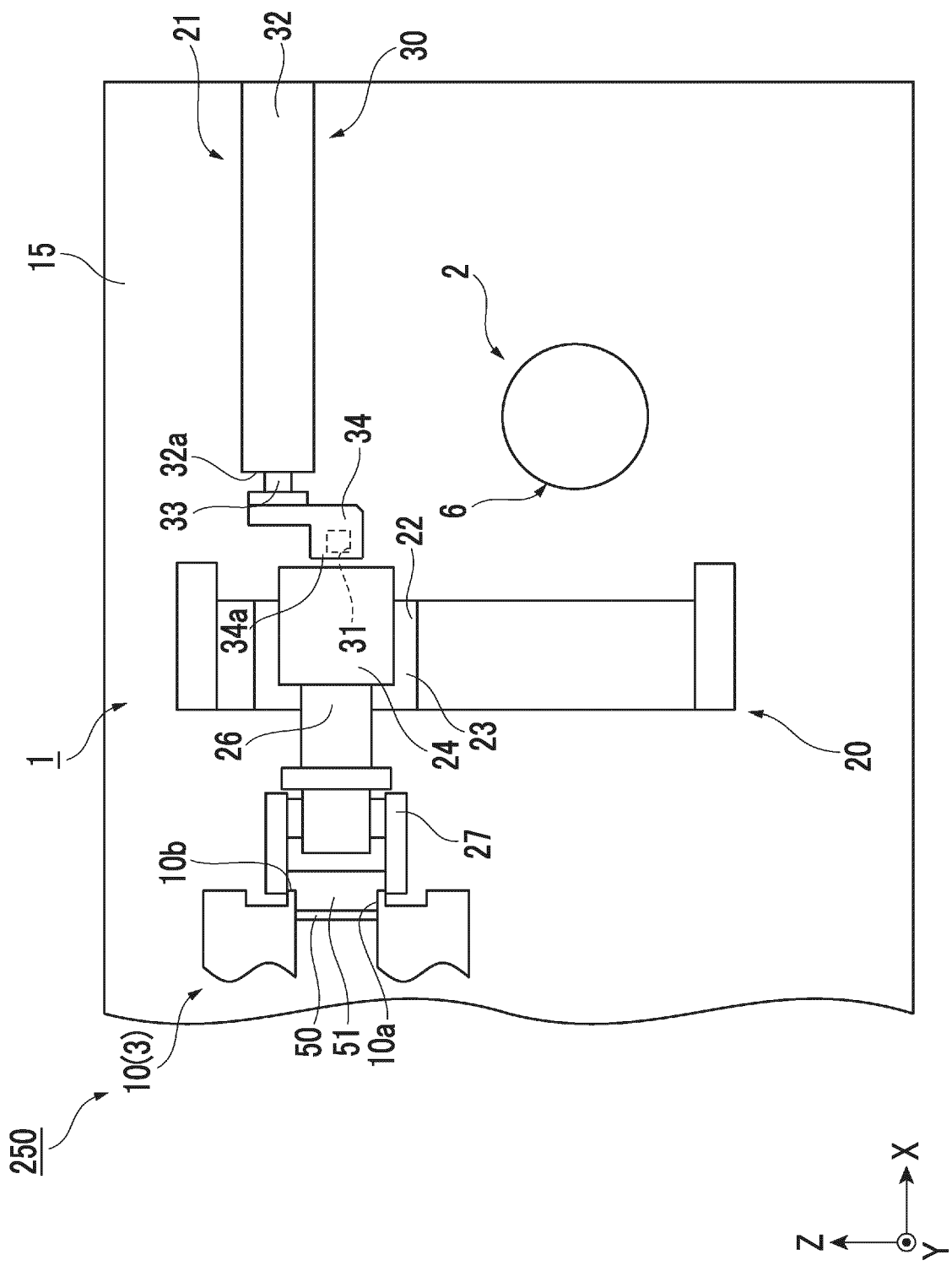


FIG. 7

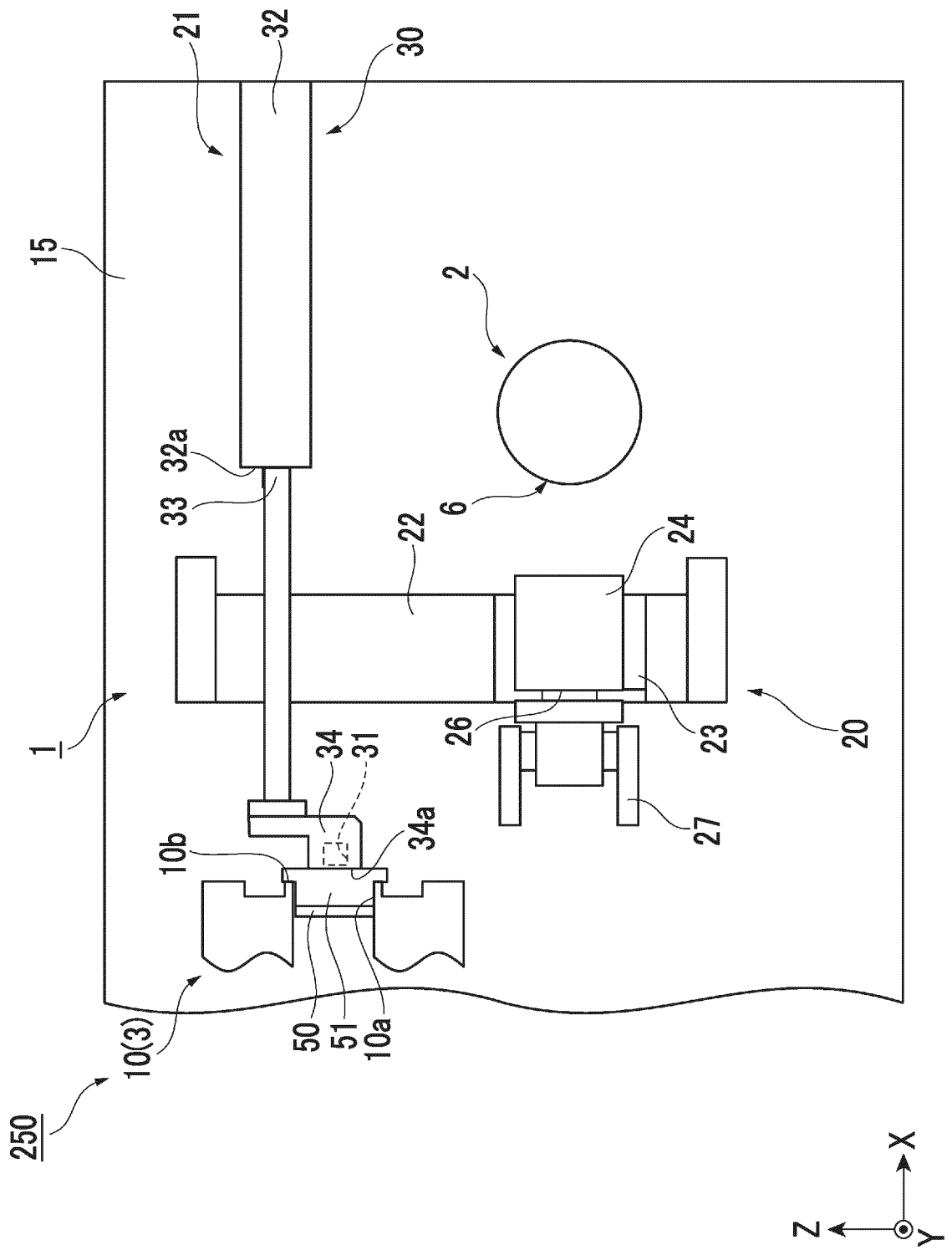
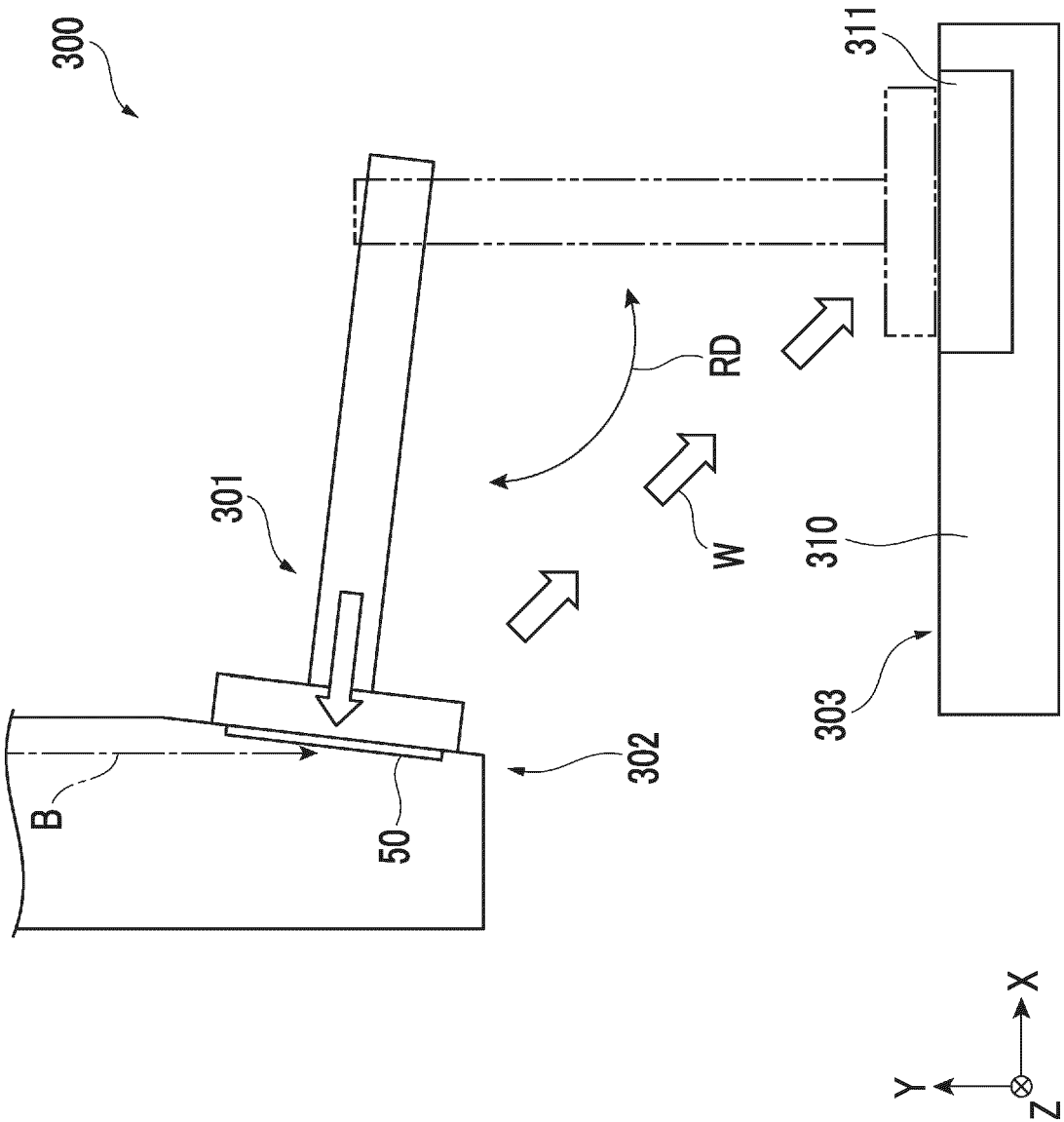


FIG. 8





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