

CONVEYANCE SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a conveyance system that conveys a workpiece to a processing apparatus.

Description of the Related Art

In a manufacturing step of device chips incorporated into electronic equipment and so forth, a plate-shaped workpiece typified by a semiconductor wafer or resin package substrate is processed by various kinds of processing apparatuses. When the workpiece is conveyed to this processing apparatus, normally a cassette for conveyance that can house plural workpieces is used.

Incidentally, in the above-described method in which plural workpieces are housed in the cassette and are conveyed to a processing apparatus at a time, unprocessed workpieces housed in the cassette are made to wait without exception when the processing apparatus stops due to any cause. That is, processing of the unprocessed workpieces by another processing apparatus also becomes impossible and thus the efficiency of the processing greatly lowers.

To solve this problem, for example, it is

preferable to convey workpieces to a processing apparatus one by one according to the operation status of the processing apparatus. Thus, a conveyance system has been proposed in which plural processing apparatuses are coupled by a path for conveyance and a workpiece can be conveyed to each processing apparatus at an arbitrary timing (for example, refer to Japanese Patent Laid-open No. Hei 6-177244).

SUMMARY OF THE INVENTION

However, a conduit connecting part to which conduits are connected, a door for maintenance, and so forth are disposed on a side surface of each processing apparatus, and the path for conveyance needs to be designed in such a manner as not to interfere with them when the above-described conveyance system is constructed. For this reason, constructing the conveyance system is not necessarily easy and the path for conveyance also tends to become long.

Thus, an object of the present invention is to provide a conveyance system that can convey a workpiece to each of plural processing apparatuses and is also easy to construct.

In accordance with an aspect of the present

invention, there is provided a conveyance system that conveys a workpiece to each of a plurality of processing apparatuses. The conveyance system includes a conveyance passage set in a space directly above the processing apparatus across a plurality of the processing apparatuses and an automated workpiece conveying vehicle including a workpiece support part that supports the workpiece, a traveling mechanism disposed on the workpiece support part, and a receiver that receives a control signal. The automated workpiece conveying vehicle travels on the conveyance passage. A stock unit includes a placement base on which a workpiece stocker capable of housing a plurality of the workpieces is placed, two temporary putting bases on which the workpiece carried out from the workpiece stocker on the placement base is temporarily put, a temporary putting base movement part that moves the two temporary putting bases in such a manner as to interchange the two temporary putting bases between a first position that faces the placement base and a second position adjacent to the first position, a workpiece conveying part that conveys the workpiece between a transfer region that faces the second position and the automated workpiece conveying vehicle, a workpiece movement unit that moves the workpiece between

the temporary putting base located at the first position and the placement base or between the temporary putting base located at the second position and the transfer region, and a receiver that receives a control signal, and a control unit including a transmitter that transmits a control signal to the processing apparatus, the automated workpiece conveying vehicle, and the stock unit, a receiver that receives a notification signal transmitted from the processing apparatus, and a control signal generating part that generates the control signal to be transmitted from the transmitter. The control signal generating part of the control unit generates the control signal to be transmitted from the transmitter of the control unit based on the notification signal received by the receiver of the control unit. The transmitter of the control unit transmits the control signal generated by the control signal generating part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, and the stock unit. The workpiece conveying part of the stock unit conveys the workpiece carried out from the workpiece stocker to the workpiece support part of the automated workpiece conveying vehicle based on the control signal received by the receiver of the stock unit. The traveling mechanism

of the automated workpiece conveying vehicle causes the automated workpiece conveying vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated workpiece conveying vehicle to convey the workpiece supported by the workpiece support part to the processing apparatus.

In this conveyance system, it is preferable that the conveyance passage be set on an upper surface of the processing apparatus.

Furthermore, in this conveyance system, it is preferable that the conveyance passage be configured by coupling a plurality of passage modules.

Moreover, in this conveyance system, the conveyance passage may include a leg part having a suction adhesion part that adheres to the processing apparatus by suction, and be fixed to the processing apparatus by the suction adhesion part.

In addition, in this conveyance system, the processing apparatus may have a conduit connecting part to which conduits are connected or a door for maintenance on a side surface in some cases.

Furthermore, this conveyance system may have the following configuration. Specifically, the conveyance system further includes an automated blade conveying

vehicle including a blade support part that supports a cutting blade used when the workpiece is processed by the processing apparatus, a traveling mechanism disposed on the blade support part, and a receiver that receives a control signal. The automated blade conveying vehicle travels on the conveyance passage. The stock unit further includes a blade conveying part that conveys the cutting blade between a blade stocker that houses the cutting blade to be supplied to the processing apparatus and the automated blade conveying vehicle. The transmitter of the control unit further has a function of transmitting the control signal to the automated blade conveying vehicle. The transmitter of the control unit transmits the control signal generated by the control signal generating part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, the automated blade conveying vehicle, and the stock unit. The blade conveying part of the stock unit conveys the cutting blade housed in the blade stocker to the blade support part of the automated blade conveying vehicle based on the control signal received by the receiver of the stock unit. The traveling mechanism of the automated blade conveying vehicle causes the automated blade conveying vehicle to travel on the conveyance passage based on the

control signal received by the receiver of the automated blade conveying vehicle to convey the cutting blade supported by the blade support part to the processing apparatus.

The conveyance system according to the aspect of the present invention includes the conveyance passage set across the plural processing apparatuses, the automated workpiece conveying vehicle including the workpiece support part, the traveling mechanism, and the receiver, and the stock unit including the workpiece conveying part and the receiver.

Thus, the workpiece can be conveyed to each of the plural processing apparatuses by conveying the workpiece housed in the workpiece stocker to the workpiece support part of the automated workpiece conveying vehicle by the workpiece conveying part and causing this automated workpiece conveying vehicle to travel on the conveyance passage.

Furthermore, in the conveyance system according to the aspect of the present invention, the conveyance passage is set in a space directly above the processing apparatus. For this reason, the structures of the side surfaces of each processing apparatus do not need to be considered when this conveyance passage is designed. That

is, construction of the conveyance system becomes easy.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view illustrating a configuration example of a conveyance system according to embodiment 1;

FIG. 2 is a functional block diagram illustrating an example of the connection relationship of the conveyance system according to embodiment 1;

FIG. 3 is a side view schematically illustrating a configuration example of a stock unit according to embodiment 1;

FIG. 4A is a perspective view illustrating a configuration example of an automated workpiece conveying vehicle;

FIG. 4B is a perspective view illustrating the automated workpiece conveying vehicle in the state in which a cassette is placed thereon;

FIG. 5 is a perspective view illustrating the appearance of a cutting apparatus, a conveyance passage, and so forth according to embodiment 1;

FIG. 6 is a perspective view illustrating a configuration example of the cutting apparatus;

FIG. 7 is a perspective view illustrating how the conveyance passage is set on the cutting apparatus;

FIG. 8A, FIG. 8B, and FIG. 8C are plan views illustrating configuration examples of a passage module;

FIG. 9 is a perspective view illustrating how the conveyance passage is formed from the passage modules;

FIG. 10A and FIG. 10B are sectional views illustrating how the passage modules are coupled;

FIG. 11 is a bottom view illustrating a configuration example of the passage module;

FIG. 12 is a perspective view illustrating the structure of the cassette and so forth;

FIG. 13A, FIG. 13B, and FIG. 13C are sectional views illustrating how a frame that supports a workpiece is carried out from the cassette;

FIG. 14 is a functional block diagram for explaining an example of operation and so forth of the conveyance system according to embodiment 1;

FIG. 15 is a functional block diagram illustrating

an example of the connection relationship of a conveyance system according to embodiment 2;

FIG. 16 is a side view illustrating a configuration example of a stock unit according to embodiment 2;

FIG. 17 is a perspective view illustrating a configuration example of an automated blade conveying vehicle;

FIG. 18 is a perspective view illustrating the appearance of a cutting apparatus and so forth according to embodiment 2;

FIG. 19 is an exploded perspective view illustrating a configuration example of a blade changer;

FIG. 20 is a functional block diagram for explaining an example of operation and so forth of the conveyance system according to embodiment 2;

FIG. 21 is a perspective view schematically illustrating how the cassette is carried out from the automated workpiece conveying vehicle in a conveyance system according to embodiment 3; and

FIG. 22 is a perspective view schematically illustrating how the cassette is carried in to the cutting apparatus in the conveyance system according to embodiment 3;

FIG. 23 is a side view schematically illustrating a

configuration example of a stock unit according to a fourth embodiment;

FIG. 24 is a plan view schematically illustrating the structure of the inside of the stock unit according to the fourth embodiment;

FIG. 25 is a side view schematically illustrating how a first temporary putting base and a second temporary putting base of the stock unit according to the fourth embodiment are moved in a second direction and the positions of the first temporary putting base and the second temporary putting base are interchanged;

FIG. 26A and FIG. 26B are plan views schematically illustrating an example of operation of the stock unit according to the fourth embodiment; and

FIG. 27A and FIG. 27B are plan views schematically illustrating the example of the operation of the stock unit according to the fourth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described with reference to the accompanying drawings. In the following respective embodiments, conveyance systems that convey workpieces and so forth to plural cutting apparatuses will be described. However, it suffices for

the conveyance system of the present invention to be configured to be capable of conveying workpieces and so forth to plural arbitrary processing apparatuses. That is, the conveyance destination of the workpiece and so forth may be a processing apparatus other than a cutting apparatus.

For example, the conveyance system of the present invention is configured to be capable of conveying workpieces to plural laser processing apparatuses in some cases. Furthermore, for example, the conveyance system of the present invention is configured to be capable of conveying a workpiece sequentially to plural kinds of processing apparatuses used for a series of processing in other cases.

(Embodiment 1)

FIG. 1 is a plan view illustrating a configuration example of a conveyance system 2 according to the present embodiment and FIG. 2 is a functional block diagram illustrating an example of the connection relationship of the conveyance system 2. As illustrated in FIG. 1, the conveyance system 2 according to the present embodiment includes a conveyance passage 6 for conveying a plate-shaped workpiece 11 processed by a cutting apparatus (processing apparatus) 4.

The workpiece 11 is a wafer that is composed of a semiconductor material such as silicon and has a circular disc shape, for example. The front surface side of this workpiece 11 is segmented into plural small regions by plural planned dividing lines (streets) intersecting each other and a device such as an integrated circuit (IC) or a micro electro mechanical system (MEMS) is formed in each small region.

A tape (dicing tape) 13 with a diameter larger than the workpiece 11 is stuck to the back surface side of the workpiece 11. The peripheral part of the tape 13 is fixed to a ring-shaped frame 15 that surrounds the workpiece 11. The workpiece 11 is conveyed to the cutting apparatus 4 in the state of being supported by the frame 15 with the intermediary of this tape 13.

Although the wafer that is composed of a semiconductor material such as silicon and has a circular disc shape is employed as the workpiece 11 in the present embodiment, there is no limit to the material, shape, structure, size, and so forth of the workpiece 11. For example, it is also possible to use a substrate or the like composed of a material such as another semiconductor, ceramic, resin, or metal as the workpiece 11. Similarly, there is no limit also to the kind, quantity, shape,

structure, size, arrangement, and so forth of the devices. The devices do not have to be formed on the workpiece 11.

Furthermore, the cutting apparatus 4 that processes this workpiece 11 is connected to the conveyance system 2 as the conveyance destination of the workpiece 11. However, the cutting apparatus 4 is not necessarily a constituent element of the conveyance system 2. Thus, the cutting apparatus 4 may be changed or omitted according to the form of use of the conveyance system 2 as described above.

Then, for convenience of description, only one cutting apparatus 4a is illustrated in FIG. 1 and two cutting apparatuses 4a and 4b are illustrated in FIG. 2. However, in the present embodiment, two or more cutting apparatuses 4 are necessary as the conveyance destination of the workpiece 11. That is, the number of processing apparatuses connected to the conveyance system 2 is two or more.

The conveyance passage 6 is disposed across plural cutting apparatuses 4 so that the workpiece 11 can be conveyed to each cutting apparatus 4. That is, the plural cutting apparatuses 4 are coupled to each other through the conveyance passage 6. Furthermore, the conveyance passage 6 is disposed in a space directly above the

cutting apparatus 4. For this reason, the conveyance passage 6 does not interfere with conduits 21 and so forth connected to a side surface of each cutting apparatus 4.

Below the conveyance passage 6, a stock unit 8 that can house plural workpieces 11 is disposed besides the cutting apparatus 4. The workpiece 11 housed in the stock unit 8 is carried in to an automated workpiece conveying vehicle 10 at an arbitrary timing. The automated workpiece conveying vehicle 10 travels on the conveyance passage 6 and conveys the workpiece 11 to each cutting apparatus 4. Although three automated workpiece conveying vehicles 10a, 10b, and 10c are illustrated in FIG. 1 and two automated workpiece conveying vehicles 10a and 10b are illustrated in FIG. 2, there is no limit to the number of automated workpiece conveying vehicles 10.

As illustrated in FIG. 2, to the cutting apparatuses 4, the stock unit 8, and the automated workpiece conveying vehicles 10, a control unit 12 that controls operation of them is wirelessly connected. However, it suffices for the control unit 12 to be configured to be capable of controlling operation of the cutting apparatuses 4, the stock unit 8, and the automated workpiece conveying vehicles 10 and the control

unit 12 may be connected to them in a wired manner in some cases.

FIG. 3 is a side view schematically illustrating a configuration example of the stock unit 8. As illustrated in FIG. 3, the stock unit 8 includes a casing 14 that houses various constituent elements. In this FIG. 3, only the contour of the casing 14 is illustrated for convenience of description.

In the casing 14, a first cassette support base 16 that moves up and down by a first raising-lowering mechanism (not illustrated) of a ball screw type is disposed, for example. A cassette (workpiece stocker) 18 that can house plural workpieces 11 is placed on the upper surface of the first cassette support base 16. This cassette 18 houses the workpieces 11 in the state of being supported by the frame 15 with the intermediary of the tape 13 as described above.

A push-pull arm 20 that can move while grasping the frame 15 is disposed on a lateral side of the first cassette support base 16. For example, when the height of the frame 15 housed in the cassette 18 is adjusted to the height of the push-pull arm 20 by the first raising-lowering mechanism and the frame 15 in the cassette 18 is grasped by this push-pull arm 20, the frame 15 can be

drawn out to the outside of the cassette 18.

A pair of guide rails 22 made to get closer to and further away from each other while the state in which the guide rails 22 are parallel to each other is kept are disposed at positions that sandwich the push-pull arm 20. Each guide rail 22 includes a support surface that supports the frame 15 from the lower side and a side surface substantially perpendicular to the support surface. The guide rails 22 sandwich the frame 15 drawn out of the cassette 18 by the push-pull arm 20 and adjust the frame 15 to a predetermined position.

On a lateral side of the push-pull arm 20 and the pair of guide rails 22, a second cassette support base 26 that moves up and down by a second raising-lowering mechanism 24 of a ball screw type is disposed, for example. A cassette (cassette for conveyance) 28 that can house one workpiece 11 is placed on the upper surface of this second cassette support base 26. The cassette 28 may be configured to be capable of housing two or more workpieces 11.

The frame 15 adjusted to the predetermined position by the pair of guide rails 22 is grasped by the push-pull arm 20 again and is inserted from a lateral side into the cassette 28 on the second cassette support base 26 whose

height is adjusted by the second raising-lowering mechanism 24. When the workpiece 11 is housed in the cassette 28, the second raising-lowering mechanism 24 raises the second cassette support base 26.

In a region directly above the second cassette support base 26, an opening 14b that vertically penetrates a ceiling 14a of the casing 14 is made. This opening 14b is formed to have shape and size that at least allow the cassette 28 to be placed on the second cassette support base 26 to pass through the opening 14b. Thus, by raising the second cassette support base 26 by the second raising-lowering mechanism 24, the cassette 28 that houses the workpiece 11 can be exposed to the outside of the casing 14 through the opening 14b.

A cassette conveying arm (workpiece conveying part) 30 that conveys the cassette 28 exposed at the opening 14b to the automated workpiece conveying vehicle 10 that has stopped near this opening 14b is disposed outside the casing 14. A control apparatus 32 for controlling operation of the stock unit 8 is connected to constituent elements such as the first raising-lowering mechanism, the push-pull arm 20, the pair of guide rails 22, the second raising-lowering mechanism 24, and the cassette conveying arm 30.

Typically, the control apparatus 32 is formed of a computer including a processing apparatus such as a central processing unit (CPU) and a storing apparatus such as a flash memory, and functions of the control apparatus 32 are implemented by causing the processing apparatus and so forth to operate in accordance with software stored in the storing apparatus.

A receiver 34 that receives a signal for control (control signal) transmitted from the control unit 12 of the conveyance system 2 and a transmitter 36 that transmits a signal for notification (notification signal) to the control unit 12 are further connected to the control apparatus 32. The control apparatus 32 controls the operation of the stock unit 8 based on the signal received by the receiver 34. Furthermore, the control apparatus 32 transmits the necessary signal to the control unit 12 through the transmitter 36.

FIG. 4A is a perspective view illustrating a configuration example of the automated workpiece conveying vehicle 10 and FIG. 4B is a perspective view illustrating the automated workpiece conveying vehicle 10 in the state in which the cassette 28 is placed thereon. As illustrated in FIG. 4A, the automated workpiece conveying vehicle 10 includes a tray-shaped chassis

(workpiece support part) 38. A recess 38a corresponding to the shape and size of the cassette 28 is made on the upper surface side of the chassis 38 and the cassette 28 conveyed by the cassette conveying arm 30 is placed in this recess 38a of the chassis 38.

Plural (in the present embodiment, four) wheels (traveling mechanism) 40 are attached to the lower surface side of the chassis 38. Each wheel 40 is coupled to a rotational drive source such as a motor and rotates. By rotating these wheels 40 by the rotational drive source, the automated workpiece conveying vehicle 10 travels on the conveyance passage 6. As the wheels 40, so-called Mecanum wheels in which plural inclined barrel-shaped (cylinder-shaped) rotating bodies are attached to the outer circumferential surface in contact with the conveyance passage 6, or the like, can be used.

A control apparatus 42 that controls operation of the automated workpiece conveying vehicle 10 is disposed on a side surface of the chassis 38. Typically, the control apparatus 42 is formed of a computer including a processing apparatus such as a CPU and a storing apparatus such as a flash memory, and functions of the control apparatus 42 are implemented by causing the processing apparatus and so forth to operate in

accordance with software stored in the storing apparatus.

To this control apparatus 42, a receiver 44 that receives a signal for control (control signal) transmitted from the control unit 12 of the conveyance system 2 and a transmitter 46 that transmits a signal for notification (notification signal) to the control unit 12 are connected. The control apparatus 42 controls the operation (traveling) of the automated workpiece conveying vehicle 10 based on the signal received by the receiver 44. Furthermore, the control apparatus 42 transmits the necessary signal to the control unit 12 through the transmitter 46.

FIG. 5 is a perspective view illustrating the appearance of the cutting apparatus 4, the conveyance passage 6, and so forth and FIG. 6 is a perspective view illustrating a configuration example of the cutting apparatus 4. As illustrated in FIG. 5 and FIG. 6, the cutting apparatus 4 includes a pedestal 48 that supports the respective constituent elements. An opening 48a is formed at a corner part of the pedestal 48 and a cassette support base 50 that moves up and down by a raising-lowering mechanism (not illustrated) is disposed in a region corresponding to this opening 48a. The above-described cassette 28 is placed on the upper surface of

the cassette support base 50. In FIG. 5 and FIG. 6, only the contour of the cassette 28 is illustrated for convenience of description.

As illustrated in FIG. 6, an opening 48b that is long in an X-axis direction (front-rear direction, processing feed direction) is formed on a lateral side of the opening 48a. An X-axis movement mechanism (processing feed unit) 52 of a ball screw type and a dust-proof and drip-proof cover 54 that covers the upper part of the X-axis movement mechanism 52 are disposed in the opening 48b. The X-axis movement mechanism 52 includes an X-axis movement table 52a and moves this X-axis movement table 52a in the X-axis direction.

A chuck table (holding table) 56 that sucks and holds the workpiece 11 is disposed on the X-axis movement table 52a. The chuck table 56 is coupled to a rotational drive source (not illustrated) such as a motor and rotates around a rotation axis substantially parallel to a Z-axis direction (vertical direction, cutting-in feed direction). Furthermore, the chuck table 56 moves in the X-axis direction (processing feed) by the above-described X-axis movement mechanism 52.

The upper surface of the chuck table 56 functions as a holding surface 56a for holding the workpiece 11.

The holding surface 56a is connected to a suction source (not illustrated) through a suction path (not illustrated) formed inside the chuck table 56 and so forth. Furthermore, four clamps 58 for fixing the frame 15 that supports the workpiece 11 from four sides are disposed around the chuck table 56.

Above the opening 48b, a pair of guide rails 60 made to get closer to and further away from each other while the state in which the guide rails 60 are parallel to a Y-axis direction (right-left direction, indexing feed direction) is kept are disposed. The pair of guide rails 60 each include a support surface that supports the frame 15 from the lower side and a side surface substantially perpendicular to the support surface. The guide rails 60 sandwich the frame 15 drawn out of the cassette 28 in the X-axis direction and adjust the frame 15 to a predetermined position.

A first support structure 62 with a gate shape is disposed to straddle the opening 48b over the pedestal 48. A first rail 64 along the Y-axis direction is fixed to the front surface of the first support structure 62 (surface on the side of the guide rails 60) and a first conveying unit 68 is coupled to this first rail 64 with the intermediary of a first movement mechanism 66 and so

forth.

For example, the first conveying unit 68 gets contact with the upper surface of the frame 15 to suck and hold this frame 15 and moves up and down by the first movement mechanism 66. In addition, the first conveying unit 68 moves in the Y-axis direction along the first rail 64. A grasping mechanism 68a for grasping the frame 15 is disposed on the first conveying unit 68 on the side of the opening 48a.

For example, when the frame 15 is grasped by the grasping mechanism 68a and the first conveying unit 68 is moved in the Y-axis direction, the frame 15 in the cassette 28 can be drawn out to the pair of guide rails 60 or the frame 15 on the pair of guide rails 60 can be inserted into the cassette 28. After the position of the frame 15 is adjusted by the pair of guide rails 60, this frame 15 (workpiece 11) is carried in to the chuck table 56 by the first conveying unit 68.

Furthermore, on the front surface of the first support structure 62, a second rail 70 along the Y-axis direction is fixed to the upper side of the first rail 64. A second conveying unit 74 is coupled to this second rail 70 with the intermediary of a second movement mechanism 72 and so forth. For example, the second conveying unit

74 gets contact with the upper surface of the frame 15 to suck and hold this frame 15 and moves up and down by the second movement mechanism 72. In addition, the second conveying unit 74 moves in the Y-axis direction along the second rail 70.

A second support structure 76 with a gate shape is disposed on the rear side of the first support structure 62. Two sets of cutting units 80 are each disposed on the front surface of the second support structure 76 (surface on the side of the first support structure 62) with the intermediary of a Y-axis/Z-axis movement mechanism (indexing feed unit, cutting-in feed unit) 78. The cutting unit 80 moves in the Y-axis direction (indexing feed) and moves in the Z-axis direction (cutting-in feed) by the Y-axis/Z-axis movement mechanism 78.

Each cutting unit 80 includes a spindle (not illustrated) that serves as a rotating shaft substantially parallel to the Y-axis direction. A cutting blade 82 with a circular ring shape is mounted to one end side of the spindle. A rotational drive source (not illustrated) such as a motor is coupled to the other end side of each spindle. Furthermore, a nozzle for supplying a cutting liquid such as purified water to the workpiece 11 and the cutting blade 82 is disposed near the cutting

blade 82.

While the cutting liquid is supplied from this nozzle, the rotated cutting blade 82 is caused to cut into the workpiece 11 held by the chuck table 56. Thereby, the workpiece 11 can be cut. An imaging unit (camera) 84 for imaging the workpiece 11 held by the chuck table 56 and so forth is disposed at a position adjacent to the cutting unit 80. This imaging unit 84 also moves in the Y-axis direction and moves in the Z-axis direction by the Y-axis/Z-axis movement mechanism 78.

A cleaning unit 86 is disposed at a position on the opposite side to the opening 48a across the opening 48b. The cleaning unit 86 includes a spinner table 88 that sucks and holds the workpiece 11 in a cleaning space with a cylindrical shape. A rotational drive source (not illustrated) that rotates the spinner table 88 at a predetermined speed is coupled to the lower part of the spinner table 88.

A spray nozzle 90 that sprays a fluid for cleaning (typically, mixed fluid obtained by mixing water and air) toward the workpiece 11 held by the spinner table 88 is disposed above the spinner table 88. The workpiece 11 can be cleaned by rotating the spinner table 88 that holds the workpiece 11 and spraying the fluid for cleaning from

the spray nozzle 90.

After the workpiece 11 is cut by the cutting unit 80, the frame 15 is conveyed to the cleaning unit 86 by the second conveying unit 74, for example. After the workpiece 11 is cleaned by the cleaning unit 86, for example, the frame 15 is placed on the pair of guide rails 60 by the first conveying unit 68 and thereafter this frame 15 is grasped by the grasping mechanism 68a and is housed in the cassette 28.

As illustrated in FIG. 5, the upper surface side of the pedestal 48 is covered by a cover 92 and the above-described respective constituent elements are housed inside the cover 92. An opening 92b that vertically penetrates a ceiling 92a of the cover 92 is made in a region directly above the opening 48a. Thus, when the cassette support base 50 is raised by the raising-lowering mechanism, the upper surface of the cassette support base 50 can be exposed to the outside of the cover 92 through this opening 92b. The shape and size of the opening 92b are the same as the shape and size of the opening 48a made in the pedestal 48, for example.

On the ceiling 92a of the cover 92, a cassette conveying arm 94 that conveys the cassette 28 between the cassette support base 50 located at a height equivalent

to that of the opening 92b and the automated workpiece conveying vehicle 10 that has stopped near the opening 92b is disposed, for example. This cassette conveying arm 94 is connected to a control apparatus 96 together with the raising-lowering mechanism and so forth, the raising-lowering mechanism raises and lowers the cassette support base 50 (FIG. 5).

Typically, the control apparatus 96 is formed of a computer including a processing apparatus such as a CPU and a storing apparatus such as a flash memory, and functions of the control apparatus 96 are implemented by causing the processing apparatus and so forth to operate in accordance with software stored in the storing apparatus.

A receiver 98 that receives a signal for control (control signal) transmitted from the control unit 12 of the conveyance system 2 and a transmitter 100 that transmits a signal for notification (notification signal) to the control unit 12 are further connected to the control apparatus 96. The control apparatus 96 controls the respective constituent elements of the above-described cutting apparatus 4 based on the signal received by the receiver 98 and so forth, for example.

A conduit connecting part 48c (FIG. 5) to which

various conduits 21 are connected is disposed in a sidewall of the pedestal 48. Furthermore, doors 92c (FIG. 5) opened and closed in maintenance or the like are disposed in a sidewall of the cover 92. Moreover, an operation panel (not illustrated), a display (not illustrated), and so forth may be disposed on a sidewall of the cover 92.

FIG. 7 is a perspective view illustrating how the conveyance passage 6 of the conveyance system 2 is set on the cutting apparatus 4. As illustrated in FIG. 7 and so forth, the conveyance passage 6 of the conveyance system 2 according to the present embodiment is mounted to the upper surface side of the ceiling 92a of the cover 92 which the cutting apparatus 4 has. That is, the conveyance passage 6 is set in a space directly above the cutting apparatus 4.

This eliminates interference of the conveyance passage 6 with the structures such as the conduit connecting part 48c and the doors 92c disposed in side surfaces of the cutting apparatus 4. That is, the structures of the side surfaces of the cutting apparatus 4 do not need to be considered when the conveyance passage 6 is designed. For this reason, construction of the conveyance system 2 becomes easy.

FIG. 8A is a plan view illustrating a configuration example of a passage module 6a used for the conveyance passage 6. FIG. 8B is a plan view illustrating a configuration example of a passage module 6b. FIG. 8C is a plan view illustrating a configuration example of a passage module 6c. The conveyance passage 6 is configured by combining the plural passage modules 6a, 6b, and 6c illustrated in FIG. 8A, FIG. 8B, and FIG. 8C, for example.

The respective passage modules 6a, 6b, and 6c each include a passage part 102 having an upper surface that is suitable for traveling of the automated workpiece conveying vehicle 10 and has high flatness and a guide part 104 that is disposed at ends of the passage part 102 in the width direction and is along this passage part 102. The height of the upper end of the guide part 104 from the passage part 102 is higher than the height of the wheels 40 of the automated workpiece conveying vehicle 10, for example. This can prevent the automated workpiece conveying vehicle 10 that travels on the passage part 102 from falling off from the passage part 102.

The passage module 6a of FIG. 8A further has a waiting part 106 for allowing the automated workpiece conveying vehicle 10 to wait, and is set directly above the cutting apparatus 4 or the like that exchanges the

workpiece 11 (cassette 28) with the automated workpiece conveying vehicle 10, for example. Meanwhile, the passage module 6b of FIG. 8B is formed into a straight line shape and the passage module 6c of FIG. 8C is formed into a right-angle shape suitable for a corner.

The passage modules 6b and 6c are used to join adjacent two passage modules 6a, for example. However, there is no limit to the kind, quantity, arrangement (relationship of the connection), and so forth of the passage module configuring the conveyance passage 6. For example, two passage modules 6a may be joined by yet another passage module 6a. Furthermore, for example, it is also possible to use a passage module with a circular arc shape (curved shape) instead of the passage module 6c with the right-angle shape.

FIG. 9 is a perspective view illustrating how the conveyance passage 6 is formed from the passage module 6a and the passage module 6b. FIG. 10A and FIG. 10B are sectional views illustrating how the passage module 6a and the passage module 6b are coupled. Furthermore, FIG. 11 is a bottom view illustrating a configuration example of the passage module 6b.

As illustrated in FIG. 9, a pair of angles (brackets) 108 whose section has an L-shape are disposed

at an end part of the lower surface of the passage part 102 in the length direction (end part in the direction along the conveyance passage 6). Each angle 108 includes a substantially-horizontal support surface 108a and a side surface 108b substantially perpendicular to the support surface 108a, and is fixed to the lower surface of the passage part 102 in such a manner that the longitudinal direction of each angle 108 is along the conveyance passage 6.

When the passage module 6a and the passage module 6b are coupled, first, as illustrated in FIG. 10A, an end part of the passage part 102 configuring the passage module 6a in the longitudinal direction and an end part of the passage part 102 configuring the passage module 6b in the longitudinal direction are brought sufficiently close to each other. Then, as illustrated in FIG. 10B, coupling pieces 110 are each inserted into the angle 108 disposed on the passage part 102 configuring the passage module 6a and the angle 108 disposed on the passage part 102 configuring the passage module 6b.

For example, the coupling piece 110 includes a rod part 110a longer than the length obtained by adding the length of the angle 108 of the passage module 6a and the length of the angle 108 of the passage module 6b and ring

parts 110b that are disposed at both ends of the rod part 110a and have an opening at the center. The rod parts 110a of these coupling pieces 110 are inserted into the angles 108.

After the rod parts 110a are inserted into the angles 108, bolts 112 are fastened into bolt holes (not illustrated) on the lower surface side of the passage part 102 through the openings of the ring parts 110b. This can couple the passage module 6a and the passage module 6b through the coupling pieces 110. The passage module 6c is also coupled to other passage modules (passage module 6a, passage module 6b, and so forth) by the same procedure.

Mounting of the passage modules 6a, 6b, and 6c to the cutting apparatus 4 is executed with the intermediary of a leg member 114 illustrated in FIG. 9, FIG. 11, and so forth, for example. The leg member 114 includes a plate-shaped base part 114a, a column part 114b that protrudes from the vicinity of the center of a surface of the base part 114a on one side and has a column shape, and a suction adhesion part 114c (FIG. 11) that is mounted to the tip of the column part 114b and has a suction cup shape.

In a region that does not overlap with the column

part 114b in the base part 114a, four openings 114d that penetrate this base part 114a in the thickness direction are formed. Furthermore, in the lower surfaces of the passage parts 102 configuring the passage modules 6a, 6b, and 6c, bolt holes 102a (FIG. 11) corresponding to the respective openings 114d are formed.

Thus, when the surface of the base part 114a on the other side is brought into contact with the lower surface of the passage part 102 and bolts 116 are fastened into the bolt holes 102a through the openings 114d, the leg member 114 can be fixed to the passage module 6a, 6b, or 6c. There is no limit to the quantity, arrangement, and so forth of the openings 114d and the bolt holes 102a.

As illustrated in FIG. 11, four bolt holes 102a corresponding to four openings 114d of the base part 114a are formed in each of plural regions of the lower surface of the passage part 102 in the passage module 6b of the present embodiment, and the leg member 114 can be mounted to an arbitrary region. This is similar also to the other passage modules 6a and 6c.

That is, the leg member 114 is mounted to any region selected from the plural regions of the lower surface of the passage part 102. It is desirable to mount plural leg members 114 to each of the passage modules 6a,

6b, and 6c. This makes it easy to stabilize the position of the conveyance passage 6 relative to the cutting apparatus 4.

When the passage module 6a, 6b, or 6c is mounted to the cutting apparatus 4, for example, the position of the passage module 6a, 6b, or 6c is adjusted to the cover 92 of the cutting apparatus 4 and the suction adhesion parts 114c of the leg members 114 are pressed against the upper surface of the ceiling 92a of the cover 92 as illustrated in FIG. 7. This can cause the suction adhesion parts 114c to adhere to the upper surface of the ceiling 92a of the cover 92 by suction and mount the arbitrary passage module 6a, 6b, or 6c to the cover 92. That is, the arbitrary passage module 6a, 6b, or 6c is mounted to the cover 92 of the cutting apparatus 4 with the intermediary of the leg members 114.

All the passage modules 6a, 6b, and 6c do not necessarily have to be mounted to the cutting apparatus 4. For example, the passage module located between two cutting apparatuses 4 is often supported by only the passage module adjacent with the intermediary of the coupling piece 110. Furthermore, as illustrated in FIG. 1, an information providing part 102b such as an identification code typified by a two-dimensional code or

a wireless tag is set on the passage part 102 of the passage module mounted to the cutting apparatus 4, the stock unit 8, or the like. This information providing part 102b is used for a check of the position of the automated workpiece conveying vehicle 10 and so forth, for example.

Next, the structure of the cassette 28 and so forth used for conveyance of the workpiece 11 will be described. FIG. 12 is a perspective view illustrating the structure of the cassette 28 and so forth. The cassette 28 includes a box body 118 with a size that allows housing of the frame 15 that supports the workpiece 11. This box body 118 has a bottom plate 120 for supporting the workpiece 11 and the frame 15.

The bottom plate 120 is formed into a rectangular shape in plan view and the lower end sides of a side plate 122, a side plate 124, and a side plate 126 are fixed to positions corresponding to three sides of the bottom plate 120. A top plate 128 with the same shape as the bottom plate 120 is fixed to the upper end sides of the side plate 122, the side plate 124, and the side plate 126. That is, the box body 118 is formed into a hollow rectangular parallelepiped shape having an opening 118a in one of the four side surfaces.

It is desirable for the top plate 128 to be formed of a material such as resin or glass that allows transmission of a visible light ray with a wavelength of about 360 nm to 830 nm. This makes it possible to discriminate the kind and so forth of the workpiece 11 housed in the box body 118 from the outside of the cassette 28, for example. When the kind and so forth of the workpiece 11 are discriminated, an identification code 17 such as a barcode drawn on the workpiece 11 may be read.

Furthermore, two movement restricting members 130a and 130b for restricting movement of the frame 15 housed in the box body 118 to the outside are disposed in a region on the bottom plate 120 on the side of the opening 118a. The two movement restricting members 130a and 130b are each formed into a rectangular parallelepiped shape and are disposed in such a manner that the longitudinal direction of the respective movement restricting members 130a and 130b is along the lower edge of the opening 118a.

The height of the two movement restricting members 130a and 130b is lower than the height of the opening 118a and a gap for carrying in and out the workpiece 11 and the frame 15 is formed between the respective movement restricting members 130a and 130b and the top

plate 128. The two movement restricting members 130a and 130b are not in contact with each other. That is, a predetermined gap 130c is formed between the movement restricting member 130a and the movement restricting member 130b.

At part of the bottom plate 120, plural openings 120a that penetrate this bottom plate 120 in the thickness direction and have a rectangular shape in plan view are formed. Each opening 120a is made in a region directly below the frame 15 housed in the box body 118, for example. That is, each opening 120a is formed at a position overlapping with the frame 15 housed in the box body 118 in plan view.

As illustrated in FIG. 12, for example, plural protrusions 50a that correspond to the shape of the opening 120a and have a rectangular parallelepiped shape are disposed on the upper surface of the cassette support base 50 which the cutting apparatus 4 has. Each protrusion 50a is disposed at the position corresponding to the opening 120a of the cassette 28 placed on the upper surface of the cassette support base 50. Thus, for example, when the cassette 28 on the automated workpiece conveying vehicle 10 is conveyed by the cassette conveying arm 94 and is placed on the upper surface of

the cassette support base 50, the protrusions 50a are inserted into the openings 120a of this cassette 28.

As a result, the frame 15 housed in the cassette 28 is pushed up to a position higher than the movement restricting members 130a and 130b relatively by the protrusions 50a, and the state in which the frame 15 can be carried out from the gap between the movement restricting members 130a and 130b and the top plate 128 is obtained. There is no particular limit to the shape and so forth of the openings 120a and the protrusions 50a. Furthermore, although only the cassette support base 50 which the cutting apparatus 4 has is exemplified in FIG. 12, the structure of the second cassette support base 26 which the stock unit 8 has and so forth are also the same, for example.

FIG. 13A, FIG. 13B, and FIG. 13C are sectional views illustrating how the frame 15 that supports the workpiece 11 is carried out from the cassette 28. For example, when the frame 15 is carried out from the cassette 28 in the cutting apparatus 4, the cassette 28 is placed on the upper surface of the cassette support base 50 in such a manner that the protrusions 50a are inserted into the openings 120a as illustrated in FIG. 13A. As a result, the frame 15 housed in the cassette is

pushed up to a position higher than the movement restricting members 130a and 130b relatively by the protrusions 50a.

Next, the relative height between the cassette support base 50 and the grasping mechanism 68a is adjusted in such a manner that the height of the upper surface of the protrusions 50a of the cassette support base 50 becomes substantially the same as that of the grasping mechanism 68a of the first conveying unit 68. Then, as illustrated in FIG. 13B, the grasping mechanism 68a of the first conveying unit 68 is inserted from the opening 118a into the cassette 28. Specifically, the first conveying unit 68 is horizontally moved and the grasping mechanism 68a is inserted into the gap 130c between the movement restricting member 130a and the movement restricting member 130b.

Thereafter, the frame 15 is grasped by the grasping mechanism 68a, and the first conveying unit 68 is horizontally moved to draw this grasping mechanism 68a from the cassette 28 as illustrated in FIG. 13C. Thereby, the frame 15 is carried out from the cassette 28. The carried-out frame 15 is carried in to the chuck table 56 after the position is adjusted by the pair of guide rails 60, for example.

Next, an example of operation and so forth of the conveyance system 2 according to the present embodiment will be described. FIG. 14 is a functional block diagram for explaining the example of operation and so forth of the conveyance system 2. For example, when the situation in which the new workpiece 11 is necessary occurs, the control apparatus 96 of the cutting apparatus 4 generates a notification signal (workpiece request signal) for notifying this. The notification signal (workpiece request signal) generated by the control apparatus 96 is transmitted from the transmitter 100 to the control unit 12.

As illustrated in FIG. 14, the control unit 12 includes a control part (control signal generating part) 132 that generates a control signal for executing various kinds of control. Typically, the control part 132 is formed of a computer including a processing apparatus such as a CPU and a storing apparatus such as a flash memory, and functions of the control part 132 are implemented by causing the processing apparatus and so forth to operate in accordance with software stored in the storing apparatus.

To this control part 132, a receiver 134 that receives notification signals transmitted from the

cutting apparatus 4, the stock unit 8, the automated workpiece conveying vehicle 10, and so forth and a transmitter 136 that transmits control signals to the cutting apparatus 4, the stock unit 8, the automated workpiece conveying vehicle 10, and so forth are connected.

When receiving the notification signal (workpiece request signal) transmitted from the transmitter 100 of the cutting apparatus 4, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (workpiece request signal) from the cutting apparatus 4, the control part 132 issues, to the automated workpiece conveying vehicle 10, an instruction to wait at a position at which the workpiece 11 can be received from the stock unit 8. Specifically, the control part 132 generates a control signal (first wait instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the automated workpiece conveying vehicle 10.

When receiving the control signal (first wait instruction signal) from the control unit 12, the receiver 44 of the automated workpiece conveying vehicle 10 sends it to the control apparatus 42. The control apparatus 42 controls operation of the wheels (traveling

mechanism) 40 and so forth based on this control signal (first wait instruction signal) and causes the automated workpiece conveying vehicle 10 to travel along the conveyance passage 6.

As illustrated in FIG. 14, a reader 138 for reading information of the information providing part 102b set on the conveyance passage 6 is connected to the control apparatus 42 of the automated workpiece conveying vehicle 10. Thus, the control apparatus 42 can check the position of the automated workpiece conveying vehicle 10 by reading the information of the information providing part 102b by the reader 138.

When confirming that the automated workpiece conveying vehicle 10 has moved to near the stock unit 8, the control apparatus 42 stops the wheels 40 and so forth. Furthermore, the control apparatus 42 generates a notification signal (first standby signal) for notifying that the automated workpiece conveying vehicle 10 is waiting at a position at which the workpiece 11 can be received. The notification signal (first standby signal) generated by the control apparatus 42 is transmitted from the transmitter 46 to the control unit 12.

When receiving the notification signal (first standby signal) transmitted from the transmitter 46 of

the automated workpiece conveying vehicle 10, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (first standby signal) from the automated workpiece conveying vehicle 10, the control part 132 issues, to the stock unit 8, an instruction to convey the workpiece 11 to the automated workpiece conveying vehicle 10. Specifically, the control part 132 generates a control signal (first conveyance instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the stock unit 8.

When receiving the control signal (first conveyance instruction signal) from the control unit 12, the receiver 34 of the stock unit 8 sends it to the control apparatus 32. The control apparatus 32 controls operation of the cassette conveying arm 30 and so forth based on this control signal (first conveyance instruction signal) to place the cassette 28 in which the workpiece 11 is housed on the chassis 38 of the automated workpiece conveying vehicle 10.

When the conveyance of the cassette 28 to the automated workpiece conveying vehicle 10 has been completed, the control apparatus 32 generates a notification signal (first conveyance completion signal)

for notifying that the conveyance of the cassette 28 to the automated workpiece conveying vehicle 10 has been completed. The notification signal (first conveyance completion signal) generated by the control apparatus 32 is transmitted from the transmitter 36 to the control unit 12.

When receiving the notification signal (first conveyance completion signal) transmitted from the transmitter 36 of the stock unit 8, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (first conveyance completion signal) from the stock unit 8, the control part 132 issues, to the automated workpiece conveying vehicle 10, an instruction to move to a position at which the workpiece 11 can be transferred to the cutting apparatus 4 and wait. Specifically, the control part 132 generates a control signal (second wait instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the automated workpiece conveying vehicle 10.

When receiving the control signal (second wait instruction signal) from the control unit 12, the receiver 44 of the automated workpiece conveying vehicle 10 sends it to the control apparatus 42. The control

apparatus 42 controls operation of the wheels 40 and so forth based on this control signal (second wait instruction signal) and causes the automated workpiece conveying vehicle 10 to travel along the conveyance passage 6.

When confirming that the automated workpiece conveying vehicle 10 has moved to near the cutting apparatus 4, the control apparatus 42 stops the wheels 40 and so forth. Furthermore, the control apparatus 42 generates a notification signal (second standby signal) for notifying that the automated workpiece conveying vehicle 10 is waiting at a position at which the workpiece 11 can be transferred to the cutting apparatus 4. The notification signal (second standby signal) generated by the control apparatus 42 is transmitted from the transmitter 46 to the control unit 12.

When receiving the notification signal (second standby signal) transmitted from the transmitter 46 of the automated workpiece conveying vehicle 10, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (second standby signal) from the automated workpiece conveying vehicle 10, the control part 132 issues, to the cutting apparatus 4, an instruction to convey the

workpiece 11 from the automated workpiece conveying vehicle 10. Specifically, the control part 132 generates a control signal (second conveyance instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the cutting apparatus 4.

When receiving the control signal (second conveyance instruction signal) from the control unit 12, the receiver 98 of the cutting apparatus 4 sends it to the control apparatus 96. The control apparatus 96 controls operation of the cassette conveying arm 94 and so forth based on this control signal (second conveyance instruction signal) to carry out the cassette 28 in which the workpiece 11 is housed from the chassis 38 of the automated workpiece conveying vehicle 10 and place the cassette 28 on the cassette support base 50.

When the conveyance of the cassette 28 to the cutting apparatus 4 has been completed, the control apparatus 96 generates a notification signal (second conveyance completion signal) for notifying that the conveyance of the cassette 28 to the cutting apparatus 4 has been completed, for example. The notification signal (second conveyance completion signal) generated by the control apparatus 96 is transmitted from the transmitter 100 to the control unit 12.

By such a procedure, the workpieces 11 housed in the stock unit 8 can be conveyed to an arbitrary cutting apparatus 4 one by one. Although the procedure when the workpiece 11 is conveyed to the cutting apparatus 4 is mainly described here, the procedure when the workpiece 11 and the cassette 28 is collected from the cutting apparatus 4, or the like, is also the same.

Furthermore, the above-described procedure can be changed within a range in which the workpiece 11 can be properly conveyed. For example, plural steps included in the above-described procedure may be simultaneously executed, and the order of the steps may be changed within a range in which no trouble is caused in the conveyance of the workpiece 11. Similarly, an arbitrary step may be added, changed, or omitted within a range in which no trouble is caused in the conveyance of the workpiece 11.

As described above, the conveyance system 2 according to the present embodiment includes the conveyance passage 6 set across plural cutting apparatuses (processing apparatuses) 4, the automated workpiece conveying vehicle 10 including the chassis (workpiece support part) 38, the wheels (traveling mechanism) 40, and the receiver 44, and the stock unit 8

including the cassette conveying arm (workpiece conveying part) 30 and the receiver 34.

Thus, the workpiece 11 can be conveyed to each of the plural cutting apparatuses 4 by conveying the workpiece 11 housed in the cassette (workpiece stocker) 18 to the chassis 38 of the automated workpiece conveying vehicle 10 by the cassette conveying arm 30 and causing this automated workpiece conveying vehicle 10 to travel on the conveyance passage 6. Furthermore, in the conveyance system 2 according to the present embodiment, the conveyance passage 6 is set in a space directly above the cutting apparatus 4. For this reason, the structures of the side surfaces of each cutting apparatus 4 do not need to be considered when this conveyance passage 6 is designed. That is, construction of the conveyance system 2 becomes easy.

(Embodiment 2)

In the present embodiment, a conveyance system that treats the cutting blade 82 and so forth as the target of conveyance in addition to the workpiece 11 will be described. The basic configuration of the conveyance system according to the present embodiment is the same as the basic configuration of the conveyance system 2 according to embodiment 1. Thus, a constituent element

common to the conveyance system 2 of embodiment 1 is given the same numeral, and the detailed description is omitted.

FIG. 15 is a functional block diagram illustrating an example of the connection relationship of a conveyance system 202 according to the present embodiment. As illustrated in FIG. 15, the automated workpiece conveying vehicles 10, cutting apparatuses 204, automated blade conveying vehicles 206, and a stock unit 208 are wirelessly connected to the control unit 12 of the conveyance system 202 according to the present embodiment.

The automated blade conveying vehicle 206 travels on the conveyance passage 6 (see FIG. 16 and so forth) similarly to the automated workpiece conveying vehicle 10 and conveys the cutting blade 82 to each cutting apparatus 204. The stock unit 208 is configured to be capable of housing the cutting blades 82 supplied to the respective cutting apparatuses 204 in addition to plural workpieces 11.

In FIG. 15, two automated workpiece conveying vehicles 10a and 10b, two cutting apparatus 204a and 204b, and two automated blade conveying vehicles 206a and 206b are illustrated for convenience of description. However, there is no limit to the number of pieces regarding each

of them. Furthermore, the control unit 12 may be connected to the automated workpiece conveying vehicles 10, the cutting apparatuses 204, the automated blade conveying vehicles 206, the stock unit 208, and so forth in a wired manner.

FIG. 16 is a side view illustrating a configuration example of the stock unit 208 according to embodiment 2. As illustrated in FIG. 16, the basic configuration of the stock unit 208 is the same as the basic configuration of the stock unit 8 according to embodiment 1. However, a blade stocker 210 for housing plural cutting blades 82 is disposed in the stock unit 208 according to the present embodiment.

The blade stocker 210 is formed into a tray shape whose upper surface side is segmented into plural regions, for example. The cutting blade 82 is housed in each region. Furthermore, near this blade stocker 210, a blade conveying arm (blade conveying part) 212 that conveys the cutting blade 82 between the blade stocker 210 and the automated blade conveying vehicle 206 is disposed.

FIG. 17 is a perspective view illustrating a configuration example of the automated blade conveying vehicle 206. As illustrated in FIG. 17, the automated blade conveying vehicle 206 includes a chassis (blade

support part) 214 with a tray shape. Plural recesses 214a corresponding to the size of the cutting blade 82 are formed on the upper surface side of the chassis 214 and a blade case 216 that can house the cutting blade 82 is disposed in each recess 214a.

The cutting blade 82 conveyed by the blade conveying arm 212 is placed on the blade case 216 disposed in the recess 214a of this chassis 214. An information providing part 214b such as a wireless tag or identification code is set at a position corresponding to each blade case 216 (recess 214a) of the chassis 214. Thus, the cutting blade 82 housed in each blade case 216 can be easily identified.

Plural (in the present embodiment, four) wheels (traveling mechanism) 218 are attached to the lower surface side of the chassis 214. Each wheel 218 is coupled to a rotational drive source such as a motor and rotates. By rotating these wheels 218 by the rotational drive source, the automated blade conveying vehicle 206 travels on the conveyance passage 6. As the wheels 218, so-called Mecanum wheels in which plural inclined barrel-shaped (cylinder-shaped) rotating bodies are attached to the outer circumferential surface in contact with the conveyance passage 6, or the like, can be used.

A control apparatus 220 that controls operation of the automated blade conveying vehicle 206 is disposed on a side surface of the chassis 214. Typically, the control apparatus 220 is formed of a computer including a processing apparatus such as a CPU and a storing apparatus such as a flash memory, and functions of the control apparatus 220 are implemented by causing the processing apparatus and so forth to operate in accordance with software stored in the storing apparatus.

To this control apparatus 220, a receiver 222 that receives a signal for control (control signal) transmitted from the control unit 12 and a transmitter 224 that transmits a signal for notification (notification signal) to the control unit 12 are connected. The control apparatus 220 controls the operation (traveling) of the automated blade conveying vehicle 206 based on the signal received by the receiver 222. Furthermore, the control apparatus 220 transmits a necessary signal to the control unit 12 through the transmitter 224.

FIG. 18 is a perspective view illustrating the appearance of the cutting apparatus 204 and so forth. As illustrated in FIG. 18, the basic configuration of the cutting apparatus 204 is the same as the basic

configuration of the cutting apparatus 4 according to embodiment 1. However, in this cutting apparatus 204, two openings 92d that vertically penetrate the ceiling 92a of the cover 92 are further made. Each opening 92d is formed with a size that allows the cutting blade 82 to pass through the opening 92d.

Furthermore, a blade raising-lowering mechanism 226 for raising and lowering the cutting blade 82 is disposed in each opening 92d. The blade raising-lowering mechanism 226 includes a blade holding part 228 that holds the cutting blade 82 and raises and lowers this blade holding part 228. Thus, when this blade holding part 228 is raised and lowered after the blade holding part 228 is caused to hold the cutting blade 82, the cutting blade 82 can be conveyed from the outside of the cover 92 to the inside or be conveyed from the inside of the cover 92 to the outside.

Over the ceiling 92a of the cover 92, a blade conveying arm 230 that conveys the cutting blade 82 between the blade holding part 228 included in the blade raising-lowering mechanism 226 and the automated blade conveying vehicle 206 that stops near the blade raising-lowering mechanism 226 is disposed. This blade conveying arm 230 includes a blade grasping part 230a that holds

the cutting blade 82 and conveys the cutting blade 82 between the automated blade conveying vehicle 206 and the blade holding part 228 by rotating, raising and lowering this blade grasping part 230a.

A blade changer 232 that replaces the cutting blade 82 of the cutting unit 80 by automatic control is further disposed inside the cover 92 of the cutting apparatus 204. The blade changer 232 is connected to the control apparatus 96 together with the blade raising-lowering mechanism 226 and the blade conveying arm 230.

FIG. 19 is an exploded perspective view illustrating a configuration example of the blade changer 232. This blade changer 232 includes a fixed plate 234 whose position is fixed relative to the pedestal 48, the cover 92, and so forth, for example. A pair of guide rails 236 that are long in the X-axis direction are disposed on the lower surface side of the fixed plate 234. A moving plate 238 is supported by the guide rails 236 in a slidable manner along the X-axis direction.

Brackets 240 corresponding to the shapes of the guide rails 236 are disposed at end parts of the moving plate 238 in the Y-axis direction and the moving plate 238 is supported by the guide rails 236 with the intermediary of these brackets 240. A nut part 242 is

fixed to the upper surface of the moving plate 238. A ball screw 244 substantially parallel to the X-axis direction is inserted into a screw hole 242a of the nut part 242 in a rotatable manner.

A pulse motor 246 is coupled to one end of the ball screw 244. When the ball screw 244 is rotated by this pulse motor 246, the moving plate 238 moves in the X-axis direction along the guide rails 236. A changer support structure 248 is fixed to the lower surface side of the moving plate 238.

A pair of nut attaching-detaching mechanisms 250 for attaching and detaching a fixing nut (not illustrated) that fixes the cutting blade 82 to the cutting unit 80 are supported by the changer support structure 248. Each nut attaching-detaching mechanism 250 is configured to be capable of moving along the Y-axis direction and rotating around a rotation axis parallel to the Y-axis direction. By grasping and rotating the fixing nut by this nut attaching-detaching mechanism 250, the fixing nut can be attached to the cutting unit 80 or the fixing nut can be detached from the cutting unit 80.

Furthermore, a pair of blade replacement mechanisms 252 for replacing the cutting blade 82 are supported by the changer support structure 248. Each blade replacement

mechanism 252 includes a first blade holding part 252a and a second blade holding part 252b that can each hold the cutting blade 82. This blade replacement mechanism 252 is configured to be capable of moving along the Y-axis direction and exchanging the positions of the first blade holding part 252a and the second blade holding part 252b in the X-axis direction.

When the cutting blade 82 is replaced by the blade changer 232, for example, the cutting blade 82 for replacement held by the blade holding part 228 of the blade raising-lowering mechanism 226 is received by the first blade holding part 252a. Then, the fixing nut is detached from the cutting unit 80 by the nut attaching-detaching mechanism 250. Furthermore, the cutting blade 82 mounted to the cutting unit 80 is detached from the cutting unit 80 by the second blade holding part 252b.

Thereafter, the positions of the first blade holding part 252a and the second blade holding part 252b are exchanged and the cutting blade 82 for replacement is attached to the cutting unit 80 by the first blade holding part 252a. Then, finally the fixing nut is attached to the cutting unit 80 by the nut attaching-detaching mechanism 250. The cutting blade 82 previously mounted to the cutting unit 80 is transferred from the

second blade holding part 252b to the blade holding part 228 of the blade raising-lowering mechanism 226, for example.

Next, an example of operation and so forth of the conveyance system 202 according to the present embodiment will be described. FIG. 20 is a functional block diagram for explaining the example of operation and so forth of the conveyance system 202. The operation relating to conveyance of the workpiece 11 is the same as embodiment 1. Therefore, an example of operation relating to conveyance of the cutting blade 82 will be mainly described in the present embodiment.

For example, when the situation in which replacement of the cutting blade 82 is necessary occurs, the control apparatus 96 of the cutting apparatus 204 generates a notification signal (blade request signal) for notifying this. The notification signal (blade request signal) generated by the control apparatus 96 is transmitted from the transmitter 100 to the control unit 12.

When receiving the notification signal (blade request signal) transmitted from the transmitter 100 of the cutting apparatus 204, the receiver 134 of the control unit 12 sends it to the control part 132. When

checking the notification signal (blade request signal) from the cutting apparatus 204, the control part 132 issues, to the automated blade conveying vehicle 206, an instruction to wait at a position at which the cutting blade 82 can be received from the stock unit 208. Specifically, the control part 132 generates a control signal (first wait instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the automated blade conveying vehicle 206.

When receiving the control signal (first wait instruction signal) from the control unit 12, the receiver 222 of the automated blade conveying vehicle 206 sends it to the control apparatus 220. The control apparatus 220 controls operation of the wheels (traveling mechanism) 218 and so forth based on this control signal (first wait instruction signal) and causes the automated blade conveying vehicle 206 to travel along the conveyance passage 6.

As illustrated in FIG. 20, a reader 254 for reading information of the information providing part 102b set on the conveyance passage 6 is connected to the control apparatus 220 of the automated blade conveying vehicle 206. Thus, the control apparatus 220 can check the position of the automated blade conveying vehicle 206 by

reading the information of the information providing part 102b by the reader 254.

When confirming that the automated blade conveying vehicle 206 has moved to near the stock unit 208, the control apparatus 220 stops the wheels 218 and so forth. Furthermore, the control apparatus 220 generates a notification signal (first standby signal) for notifying that the automated blade conveying vehicle 206 is waiting at a position at which the cutting blade 82 can be received. The notification signal (first standby signal) generated by the control apparatus 220 is transmitted from the transmitter 224 to the control unit 12.

When receiving the notification signal (first standby signal) transmitted from the transmitter 224 of the automated blade conveying vehicle 206, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (first standby signal) from the automated blade conveying vehicle 206, the control part 132 issues, to the stock unit 208, an instruction to convey the cutting blade 82 to the automated blade conveying vehicle 206. Specifically, the control part 132 generates a control signal (first conveyance instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the

stock unit 208.

When receiving the control signal (first conveyance instruction signal) from the control unit 12, the receiver 34 of the stock unit 208 sends it to the control apparatus 32. The control apparatus 32 controls operation of the blade conveying arm 212 and so forth based on this control signal (first conveyance instruction signal) to carry out the cutting blade 82 from the blade stocker 210 and place the cutting blade 82 on the chassis 214 of the automated blade conveying vehicle 206. Specifically, the cutting blade 82 is placed on the blade case 216 indicated from the control unit 12 through the control signal (first conveyance instruction signal), for example.

When the conveyance of the cutting blade 82 to the automated blade conveying vehicle 206 has been completed, the control apparatus 32 generates a notification signal (first conveyance completion signal) for notifying that the conveyance of the cutting blade 82 to the automated blade conveying vehicle 206 has been completed. The notification signal (first conveyance completion signal) generated by the control apparatus 32 is transmitted from the transmitter 36 to the control unit 12.

When receiving the notification signal (first conveyance completion signal) transmitted from the

transmitter 36 of the stock unit 208, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (first conveyance completion signal) from the stock unit 208, the control part 132 issues, to the automated blade conveying vehicle 206, an instruction to move to a position at which the cutting blade 82 can be transferred to the cutting apparatus 204 and wait. Specifically, the control part 132 generates a control signal (second wait instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the automated blade conveying vehicle 206.

When receiving the control signal (second wait instruction signal) from the control unit 12, the receiver 222 of the automated blade conveying vehicle 206 sends it to the control apparatus 220. The control apparatus 220 controls operation of the wheels 218 and so forth based on this control signal (second wait instruction signal) and causes the automated blade conveying vehicle 206 to travel along the conveyance passage 6.

When confirming that the automated blade conveying vehicle 206 has moved to near the cutting apparatus 204, the control apparatus 220 stops the wheels 218 and so

forth. Furthermore, the control apparatus 220 generates a notification signal (second standby signal) for notifying that the automated blade conveying vehicle 206 is waiting at a position at which the cutting blade 82 can be transferred to the cutting apparatus 204. The notification signal (second standby signal) generated by the control apparatus 220 is transmitted from the transmitter 224 to the control unit 12.

When receiving the notification signal (second standby signal) transmitted from the transmitter 224 of the automated blade conveying vehicle 206, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (second standby signal) from the automated blade conveying vehicle 206, the control part 132 issues, to the cutting apparatus 204, an instruction to convey the cutting blade 82 from the automated blade conveying vehicle 206. Specifically, the control part 132 generates a control signal (second conveyance instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the cutting apparatus 204.

When receiving the control signal (second conveyance instruction signal) from the control unit 12, the receiver 98 of the cutting apparatus 204 sends it to

the control apparatus 96. The control apparatus 96 controls operation of the blade conveying arm 230 and so forth based on this control signal (second conveyance instruction signal) to carry out the cutting blade 82 from the chassis 214 of the automated blade conveying vehicle 206 and transfer the cutting blade 82 to the blade holding part 228. Specifically, the cutting blade 82 in the blade case 216 indicated from the control unit through the control signal (second conveyance instruction signal) is carried out to be transferred to the blade holding part 228.

When the transfer of the cutting blade 82 to the cutting apparatus 204 has been completed, the control apparatus 96 generates a notification signal (second conveyance completion signal) for notifying that the conveyance of the cutting blade 82 to the cutting apparatus 204 has been completed, for example. The notification signal (second conveyance completion signal) generated by the control apparatus 96 is transmitted from the transmitter 100 to the control unit 12. By such a procedure, the cutting blade 82 housed in the stock unit 208 can be conveyed to the cutting apparatus 204 according to need.

Thereafter, the cutting apparatus 204 transfers the

cutting blade 82 from the above-described blade holding part 228 to the blade changer 232, for example. Then, by this blade changer 232, the used cutting blade 82 that has been already mounted to the cutting unit 80 are replaced by the cutting blade 82 received from the blade holding part 228.

The used cutting blade 82 detached from the cutting unit 80 is transferred to the blade holding part 228. The blade conveying arm 230 places the used cutting blade 82 held by the blade holding part 228 on the chassis 214 of the automated blade conveying vehicle 206 that is waiting. At this time, the used cutting blade 82 is placed on the blade case 216 indicated by the control apparatus 96, for example.

When the conveyance of the used cutting blade 82 to the automated blade conveying vehicle 206 has been completed, the control apparatus 96 generates a notification signal (third conveyance completion signal) for notifying that the conveyance of the used cutting blade 82 to the automated blade conveying vehicle 206 has been completed. The notification signal (third conveyance completion signal) generated by the control apparatus 96 is transmitted from the transmitter 100 to the control unit 12. Information on the blade case 216 on which the

used cutting blade 82 is placed (information of the information providing part 214b corresponding to the blade case 216) is included in this notification signal (third conveyance completion signal).

When receiving the notification signal (third conveyance completion signal) transmitted from the transmitter 100 of the cutting apparatus 204, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (third conveyance completion signal) from the cutting apparatus 204, the control part 132 issues, to the automated blade conveying vehicle 206, an instruction to move to a position at which the used cutting blade 82 can be transferred to the stock unit 208 and wait. Specifically, the control part 132 generates a control signal (third wait instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the automated blade conveying vehicle 206.

When receiving the control signal (third wait instruction signal) from the control unit 12, the receiver 222 of the automated blade conveying vehicle 206 sends it to the control apparatus 220. The control apparatus 220 controls operation of the wheels 218 and so forth based on this control signal (third wait

instruction signal) and causes the automated blade conveying vehicle 206 to travel along the conveyance passage 6.

When confirming that the automated blade conveying vehicle 206 has moved to near the stock unit 208, the control apparatus 220 stops the wheels 218 and so forth. Furthermore, the control apparatus 220 generates a notification signal (third standby signal) for notifying that the automated blade conveying vehicle 206 is waiting at a position at which the used cutting blade 82 can be transferred. The notification signal (third standby signal) generated by the control apparatus 220 is transmitted from the transmitter 224 to the control unit 12.

When receiving the notification signal (third standby signal) transmitted from the transmitter 224 of the automated blade conveying vehicle 206, the receiver 134 of the control unit 12 sends it to the control part 132. When checking the notification signal (third standby signal) from the automated blade conveying vehicle 206, the control part 132 issues, to the stock unit 208, an instruction to carry out the used cutting blade 82 from the automated blade conveying vehicle 206. Specifically, the control part 132 generates a control signal (third

conveyance instruction signal) equivalent to this instruction and sends it from the transmitter 136 to the stock unit 208.

When receiving the control signal (third conveyance instruction signal) from the control unit 12, the receiver 34 of the stock unit 208 sends it to the control apparatus 32. The control apparatus 32 controls operation of the blade conveying arm 212 and so forth based on this control signal (third conveyance instruction signal) to carry out the used cutting blade 82 from the chassis 214 of the automated blade conveying vehicle 206 and house the used cutting blade 82 to the blade stocker 210. Specifically, the cutting blade 82 in the blade case 216 indicated from the control unit 12 through the control signal (third conveyance instruction signal) is carried out to be transferred to the blade stocker 210.

By such a procedure, the cutting blade 82 housed in the stock unit 208 can be conveyed to the cutting apparatus 204 according to need. Furthermore, the used cutting blade 82 detached from the cutting unit 80 of the cutting apparatus 204 can be collected. Here, the automated blade conveying vehicle 206 is made to wait on the spot during work of replacing the cutting blade 82. However, for example, another cutting blade 82 may be

conveyed to another cutting apparatus 204 during this work of replacing the cutting blade 82.

Furthermore, the above-described procedure can be changed within a range in which the cutting blade 82 can be properly conveyed. For example, plural steps included in the above-described procedure may be simultaneously executed and the order of the steps may be changed within a range in which no trouble is caused in the conveyance of the cutting blade 82. Similarly, an arbitrary step may be added, changed, or omitted within a range in which no trouble is caused in the conveyance of the cutting blade 82.

As described above, the conveyance system 202 according to the present embodiment includes the conveyance passage 6 set across plural cutting apparatuses (processing apparatuses) 204, the automated blade conveying vehicle 206 including the chassis (blade support part) 214, the wheels (traveling mechanism) 218, and the receiver 222, and the stock unit 208 including the blade conveying arm (blade conveying part) 212 and the receiver 34.

Thus, the cutting blade 82 can be conveyed to each of the plural cutting apparatuses 204 by conveying the cutting blade 82 housed in the blade stocker 210 to the

chassis 214 of the automated blade conveying vehicle 206 by the blade conveying arm 212 and causing this automated blade conveying vehicle 206 to travel on the conveyance passage 6. Furthermore, in the conveyance system 202 according to the present embodiment, the conveyance passage 6 is set in a space directly above the cutting apparatus 204. For this reason, the structures of the side surfaces of each cutting apparatus 204 do not need to be considered when this conveyance passage 6 is designed. That is, construction of the conveyance system 202 becomes easy.

(Embodiment 3)

In the present embodiment, an example in which a conveyance mechanism for conveying the cassette 28 (workpiece 11) to a cutting apparatus is attached to a conveyance passage will be described. The basic configuration of the cutting apparatus and the conveyance passage is the same as embodiments 1 and 2. Thus, a common constituent element is given the same numeral, and the detailed description is omitted.

FIG. 21 is a perspective view schematically illustrating how the cassette 28 is carried out from the automated workpiece conveying vehicle 10 in a conveyance system according to the present embodiment. FIG. 22 is a

perspective view schematically illustrating how the cassette 28 is carried in to a cutting apparatus (processing apparatus) 304. In FIG. 21 and FIG. 22, the constituent elements inside the cover 92 are all omitted.

As illustrated in FIG. 21 and FIG. 22, the cutting apparatus 304 used in the present embodiment is not equipped with the cassette conveying arm 94. Furthermore, in this cutting apparatus 304, the upper surface of the cassette support base 50 does not need to be exposed to the outside of the cover 92. Meanwhile, a support structure 306 is fixed to the conveyance passage 6 on the cutting apparatus 304.

A movement mechanism 308 that moves in the horizontal direction is disposed on the support structure 306. A cassette holding hand 310 that holds the cassette 28 is disposed at the lower end part of the movement mechanism 308. The cassette holding hand 310 is connected to the movement mechanism 308 in a manner capable of moving up and down like a crane, for example. Furthermore, a camera (not illustrated) used in checking whether or not the cassette 28 is present, the position of the cassette 28, and so forth is disposed on the lower surface side of the cassette holding hand 310.

When the cassette 28 is conveyed from the automated

workpiece conveying vehicle 10 to the cutting apparatus 304 in this conveyance system, first, the movement mechanism 308 is positioned above the automated workpiece conveying vehicle 10 that is waiting near the cutting apparatus 304. Next, as illustrated in FIG. 21, the cassette holding hand 310 is lowered, and the cassette 28 on the automated workpiece conveying vehicle 10 is held by this cassette holding hand 310.

Thereafter, the cassette holding hand 310 is raised. Furthermore, the movement mechanism 308 is moved to above the opening 92b of the cover 92 (i.e. above the cassette support base 50). Then, as illustrated in FIG. 22, the cassette holding hand 310 is lowered and the cassette 28 held by this cassette holding hand 310 is placed on the upper surface of the cassette support base 50. By the above-described procedure, the cassette 28 can be conveyed from the automated workpiece conveying vehicle 10 to the cutting apparatus 304.

In the conveyance system of the present embodiment, the conveyance mechanism for conveying the cassette 28 (workpiece 11) to the cutting apparatus is attached to the conveyance passage 6. Therefore, the cutting apparatus 304 does not need to be equipped with a cassette conveying arm. Thus, the general versatility of

the conveyance system becomes higher compared with the case in which the cutting apparatus is equipped with the cassette conveying arm, or the like.

(Embodiment 4)

In the present embodiment, a stock unit with a different structure from the stock unit 8 and the stock unit 208 will be described. The basic configuration of a conveyance system and so forth into which the stock unit of the present embodiment is incorporated is the same as the conveyance system and so forth according to Embodiments 1 to 3. Thus, a common constituent element is given the same numeral and detailed description is omitted.

FIG. 23 is a side view schematically illustrating a configuration example of a stock unit 408 according to the present embodiment, and FIG. 24 is a plan view schematically illustrating the structure of the inside of the stock unit 408. As illustrated in FIG. 23, the stock unit 408 includes a casing 414 that houses various constituent elements. In this FIG. 23, only the contour of the casing 414 is illustrated for convenience of description.

In the casing 414, a first cassette support base (placement base) 416 that moves up and down by a raising-

lowering mechanism (not illustrated) of a ball screw type is disposed, for example. The cassette (workpiece stocker) 18 that can house plural workpieces 11 is placed on the upper surface of the first cassette support base 416. This cassette 18 houses the workpieces 11 in the state of being supported by the frame 15 with the intermediary of the tape 13 as described above.

As illustrated in FIG. 24, a first workpiece movement unit 420 that grasps and moves the frame 15 is disposed at a first position that faces the first cassette support base 416 (cassette 18). The first workpiece movement unit 420 includes a grasping part 422 that vertically grasps the frame 15 and a drive part 424 that moves the grasping part 422 in a substantially horizontal direction.

A slit-shaped opening 424a that extends substantially horizontally toward the first cassette support base 416 is formed in the upper surface of the drive part 424, and the drive part 424 moves the grasping part 422 in a first direction along this opening 424a. That is, the grasping part 422 moves in such a manner as to get closer to the first cassette support base 416 or get further away from the first cassette support base 416.

Thus, for example, when the height of the frame 15

housed in the cassette 18 is adjusted to the height of the grasping part 422 by the raising-lowering mechanism and the grasping part 422 is brought close to the first cassette support base 416, the frame 15 in the cassette 18 can be grasped by the grasping part 422. Furthermore, when the grasping part 422 is brought further away from the first cassette support base 416 after the frame 15 in the cassette 18 is grasped by the grasping part 422, the frame 15 can be drawn out to the outside of the cassette 18.

Around the first workpiece movement unit 420, a first temporary putting base 426 on which the frame 15 carried out from the cassette 18 is temporarily put is disposed. The first temporary putting base 426 includes a pair of guide parts 426a that are each long in the first direction and a base part 426b that is long in a second direction that is perpendicular to the first direction and is horizontal. The pair of guide parts 426a are coupled through the base part 426b in such a manner that the longitudinal directions thereof are parallel to each other. The frame 15 drawn out from the cassette 18 by the first workpiece movement unit 420 is placed on the pair of guide parts 426a.

The first temporary putting base 426 is supported

by a first temporary putting base movement part 428 that moves this first temporary putting base 426 in the second direction. The first temporary putting base movement part 428 includes a guide rail 430 that is long in the second direction. A moving member 432 is slidably attached to the guide rail 430.

A nut part (not illustrated) is disposed on the moving member 432 and a ball screw (not illustrated) substantially parallel to the guide rail 430 is screwed to this nut part. A pulse motor 434 is coupled to one end of the ball screw. When the ball screw is rotated by the pulse motor 434, the moving member 432 moves in the second direction along the guide rail 430.

The base part 426b of the first temporary putting base 426 is fixed to the upper part of the moving member 432. Thus, the first temporary putting base 426 moves in the second direction together with the moving member 432. The first temporary putting base movement part 428 is configured to be capable of moving the first temporary putting base 426 between the first position and a second position adjacent to this first position.

A second workpiece movement unit 436 that grasps and moves the frame 15 is disposed at the second position. That is, the second workpiece movement unit 436 is

disposed adjacent to the first workpiece movement unit 420. The structure of the second workpiece movement unit 436 is the same as the structure of the first workpiece movement unit 420.

Specifically, the second workpiece movement unit 436 includes a grasping part 438 that vertically grasps the frame 15 and a drive part 440 that moves the grasping part 438 in a substantially horizontal direction. A slit-shaped opening 440a that is long in the first direction is formed in the upper surface of the drive part 440 and the drive part 440 moves the grasping part 438 along this opening 440a.

Around the second workpiece movement unit 436, a second temporary putting base 442 having the same structure as the first temporary putting base 426 is disposed. That is, the second temporary putting base 442 includes a pair of guide parts 442a that are each long in the first direction and a base part 442b that is long in the second direction, which is perpendicular to the first direction and is horizontal. The pair of guide parts 442a are coupled through the base part 442b in such a manner that the longitudinal directions thereof are parallel to each other.

The second temporary putting base 442 is supported

by a second temporary putting base movement part 444 that moves this second temporary putting base 442 in the second direction and the vertical direction. The second temporary putting base movement part 444 includes a guide rail 446 that is long in the second direction. A moving member 448 is slidably attached to the guide rail 446.

A nut part (not illustrated) is disposed on the moving member 448 and a ball screw (not illustrated) substantially parallel to the guide rail 446 is screwed to this nut part. A pulse motor 450 is coupled to one end of the ball screw. When the ball screw is rotated by the pulse motor 450, the moving member 448 moves in the second direction along the guide rail 446.

The base part 442b of the second temporary putting base 442 is fixed to the upper part of the moving member 448 with the intermediary of a raising-lowering mechanism 452 formed of an air cylinder and so forth. Thus, the second temporary putting base 442 moves in the second direction together with the moving member 448 and the raising-lowering mechanism 452 and moves up and down by the raising-lowering mechanism 452. The second temporary putting base movement part 444 is configured to be capable of moving the second temporary putting base 442 between the second position and the first position

adjacent to this second position.

FIG. 25 is a side view schematically illustrating how the first temporary putting base 426 and the second temporary putting base 442 are moved in the second direction and the position of the first temporary putting base 426 and the position of the second temporary putting base 442 are interchanged. When the position of the first temporary putting base 426 and the position of the second temporary putting base 442 are interchanged, first, the second temporary putting base 442 is raised by the raising-lowering mechanism 452. Specifically, the second temporary putting base 442 is positioned to a rising position at which the height of the lower end of the second temporary putting base 442 is higher than the height of the upper end of the first temporary putting base 426.

Thereafter, in the state in which the second temporary putting base 442 is positioned at the rising position, the second temporary putting base 442 is moved to the first position side by the second temporary putting base movement part 444. Furthermore, at the same timing, the first temporary putting base 426 is moved to the second position side by the first temporary putting base movement part 428. In FIG. 25, how the first

temporary putting base 426 is moved from the first position to the second position and the second temporary putting base 442 is moved from the second position to the first position is illustrated.

After the movement of the first temporary putting base 426 and the second temporary putting base 442 is completed, the second temporary putting base 442 is lowered by the raising-lowering mechanism 452 and the second temporary putting base 442 is positioned to a reference position at which the height of the lower end of the second temporary putting base 442 is substantially equal to the height of the lower end of the first temporary putting base 426. As above, in the stock unit 408, the first temporary putting base 426 and the second temporary putting base 442 can be moved to be interchanged between the first position and the second position by the first temporary putting base movement part 428 and the second temporary putting base movement part 444.

At a position that faces the second position at which the second workpiece movement unit 436 is disposed, a second cassette support base (transfer region) 454 on which the cassette (cassette for conveyance) 28 that can house one workpiece 11 is placed is disposed. The

structure of this second cassette support base 454 may be the same as the cassette support base 50 and so forth according to the above-described embodiments. However, a raising-lowering mechanism is not connected to the second cassette support base 454 of the present embodiment and this second cassette support base 454 does not move up and down.

As illustrated in FIG. 23, an opening 414b that vertically penetrates a ceiling 414a of the casing 414 is made in a region directly above the second cassette support base 454. This opening 414b is formed to have shape and size that allow the cassette 28 placed on the second cassette support base 454 to pass through the opening 414b. Furthermore, outside the casing 414, a cassette conveying arm (workpiece conveying part) 456 that conveys the cassette 28 in which the workpiece 11 is housed between the second cassette support base 454 that faces the second position and the automated workpiece conveying vehicle 10 that has stopped near the opening 414b is disposed.

The structure of this cassette conveying arm 456 is similar to the structure of the above-described movement mechanism 308 and cassette holding hand 310. Specifically, the cassette conveying arm 456 includes a movement

mechanism 458 that moves in the horizontal direction and a cassette holding hand 460 that moves up and down like a crane relative to this movement mechanism 458. A camera (not illustrated) used in checking whether or not the cassette 28 is present, the position of the cassette 28, and so forth is disposed on the lower surface side of the cassette holding hand 460.

Furthermore, a cassette holding claw 460a is disposed on the lower surface side of the cassette holding hand 460. Meanwhile, a supported plate 128b is fixed to the top plate 128 of the cassette 28 used in the present embodiment with the intermediary of a support column 128a. Thus, when the cassette holding claw 460a is inserted between the top plate 128 and the supported plate 128b and the supported plate 128b is supported by the cassette holding claw 460a, the cassette 28 can be conveyed by this cassette conveying arm 456.

A control apparatus 462 for controlling operation of the stock unit 408 is connected to constituent elements such as the raising-lowering mechanism that raises and lowers the first cassette support base 416, the first workpiece movement unit 420, the first temporary putting base movement part 428, the second workpiece movement unit 436, the second temporary putting

base movement part 444, the raising-lowering mechanism 452, and the cassette conveying arm 456.

Typically, the control apparatus 462 is formed of a computer including a processing apparatus such as a CPU and a storing apparatus such as a flash memory, and functions of the control apparatus 462 are implemented by causing the processing apparatus and so forth to operate in accordance with software stored in the storing apparatus.

A receiver 464 that receives a signal for control (control signal) transmitted from the control unit 12 of the conveyance system and a transmitter 466 that transmits a signal for notification (notification signal) to the control unit 12 are further connected to the control apparatus 462. The control apparatus 462 controls the operation of the stock unit 408 based on the signal received by the receiver 464. Furthermore, the control apparatus 462 transmits the necessary signal to the control unit 12 through the transmitter 466.

Next, operation of the stock unit 408 according to the present embodiment will be described. FIG. 26A, FIG. 26B, FIG. 27A, and FIG. 27B are plan views schematically illustrating an example of operation of the stock unit 408. In the present embodiment, the description will be

made about operation in the case in which the first temporary putting base 426 is positioned at the first position and the second temporary putting base 442 is positioned at the second position. However, operation in the case in which the first temporary putting base 426 is positioned at the second position and the second temporary putting base 442 is positioned at the first position is also the same.

For example, the cassette conveying arm 456 receives the cassette 28 in which the workpiece 11 after processing is housed from the automated workpiece conveying vehicle 10 and thereafter places this cassette 28 on the second cassette support base 454. On the first cassette support base 416, the cassette 18 in which the workpiece 11 (frame 15) before processing is housed is placed in advance.

Thereafter, as illustrated in FIG. 26A, the grasping part 422 is brought close to the cassette 18 on the first cassette support base 416 and the frame 15 housed in the cassette 18 is grasped by the grasping part 422. At the same timing, the grasping part 438 is brought close to the cassette 28 on the second cassette support base 454 and the frame 15 housed in the cassette 28 is grasped by the grasping part 438.

After the frame 15 in the cassette 18 is grasped by the grasping part 422, the grasping part 422 is brought further away from the first cassette support base 416 as illustrated in FIG. 26B. Similarly, after the frame 15 in the cassette 28 is grasped by the grasping part 438, the grasping part 438 is brought further away from the second cassette support base 454 as illustrated in FIG. 26B. Thereby, the workpiece 11 before processing is drawn out from the cassette 18 to the first temporary putting base 426, and the workpiece 11 after processing is drawn out from the cassette 28 to the second temporary putting base 442.

Next, as illustrated in FIG. 27A, the first temporary putting base 426 and the second temporary putting base 442 are moved to be interchanged between the first position and the second position. Specifically, the second temporary putting base 442 is raised by the raising-lowering mechanism 452 and is positioned to the rising position. Then, the second temporary putting base 442 is moved toward the first position side along the second direction.

Furthermore, at the same timing, the first temporary putting base 426 is moved toward the second position side along the second direction. After the

movement of the first temporary putting base 426 and the second temporary putting base 442 is completed, the second temporary putting base 442 is lowered by the raising-lowering mechanism 452 and is positioned to the reference position. As a result, the first temporary putting base 426 is positioned to the second position facing the second cassette support base 454 and the second temporary putting base 442 is positioned to the first position facing the first cassette support base 416.

Thereafter, as illustrated in FIG. 27B, the frame 15 on the first temporary putting base 426 is grasped by the grasping part 438 and the grasping part 438 is brought close to the cassette 28 on the second cassette support base 454. Thereby, the frame 15 that supports the workpiece 11 before processing and is on the first temporary putting base 426 is housed in the cassette 28 on the second cassette support base 454.

At the same timing, the frame 15 on the second temporary putting base 442 is grasped by the grasping part 422, and the grasping part 422 is brought close to the cassette 18 on the first cassette support base 416. Thereby, the frame 15 that supports the workpiece 11 after processing and is on the second temporary putting base 442 is housed in the cassette 18 on the first

cassette support base 416.

After the frame 15 on the first temporary putting base 426 is housed in the cassette 28 on the second cassette support base 454, the cassette conveying arm 456 transfers this cassette 28 to the automated workpiece conveying vehicle 10. Through the above, the workpiece 11 after processing can be conveyed from the automated workpiece conveying vehicle 10 to the stock unit 408 and the workpiece 11 before processing can be conveyed from the stock unit 408 to the automated workpiece conveying vehicle 10.

The first temporary putting base 426 and the second temporary putting base 442 have the same functions and the frame 15 carried out from the cassette 18 can be temporarily put on either of the first temporary putting base 426 or the second temporary putting base 442. For example, when the second temporary putting base 442 is positioned at the first position, the frame 15 carried out from the cassette 18 is temporarily put on the second temporary putting base 442.

Furthermore, the above-described first workpiece movement unit 420 moves the workpiece 11 between the first temporary putting base 426 or the second temporary putting base 442 positioned at the first position and the

first cassette support base 416 (cassette 18). Similarly, the second workpiece movement unit 436 moves the workpiece 11 between the second temporary putting base 442 or the first temporary putting base 426 positioned at the second position and the second cassette support base 454 (cassette 28).

The present invention is not limited to the description of the above embodiments and can be carried out with various changes. For example, the cutting apparatus 204 of the above embodiment is equipped with the blade raising-lowering mechanism 226 for raising and lowering the cutting blade 82. However, a blade raising-lowering mechanism may be attached to the conveyance passage 6. In this case, the general versatility of the conveyance system becomes higher compared with the case in which the cutting apparatus is equipped with the blade raising-lowering mechanism, or the like.

Furthermore, the conveyance passage 6 may have a space (waiting region) for allowing two automated workpiece conveying vehicles 10 or the like to pass each other. In addition, the conveyance passage 6 may be set as a so-called one-way passage on which only traveling of the automated workpiece conveying vehicle 10 or the like in one direction is permitted. In this case, the

conveyance passage 6 for outward traveling and the conveyance passage 6 for homeward traveling may be set on a cutting apparatus (processing apparatus).

Moreover, in the above embodiments, the information providing part 102b such as an identification code or wireless tag is set on the passage part 102. However, it is also possible to attach an information providing part to the guide part 104. In this case, it is preferable to attach the information providing part to a wall surface of the inside of the guide part 104, the upper end part of the guide part 104, or the like, for example.

In addition, it is also possible to incorporate the blade stocker 210, the blade conveying arm (blade conveying part) 212, and so forth of the stock unit 208 into the stock unit 408.

Besides, structures, methods, and so forth relating to the above embodiments, modification examples, and so forth can be implemented with appropriate changes without departing from the range of the object of the present invention.

The present invention is not limited to the details of the above described preferred embodiments. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the

equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A conveyance system that conveys a workpiece to each of a plurality of processing apparatuses, the conveyance system comprising:

a conveyance passage set in a space directly above the processing apparatus across a plurality of the processing apparatuses;

an automated workpiece conveying vehicle including a workpiece support part that supports the workpiece, a traveling mechanism disposed on the workpiece support part, and a receiver that receives a control signal, the automated workpiece conveying vehicle traveling on the conveyance passage;

a stock unit including a placement base on which a workpiece stocker capable of housing a plurality of the workpieces is placed, two temporary putting bases on which the workpiece carried out from the workpiece stocker on the placement base is temporarily put, a temporary putting base movement part that moves the two temporary putting bases in such a manner as to interchange the two temporary putting bases between a first position that faces the placement base and a second position adjacent to the first position, a workpiece conveying part that conveys the workpiece between a

transfer region that faces the second position and the automated workpiece conveying vehicle, a workpiece movement unit that moves the workpiece between the temporary putting base located at the first position and the placement base or between the temporary putting base located at the second position and the transfer region, and a receiver that receives a control signal; and

a control unit including a transmitter that transmits a control signal to the processing apparatus, the automated workpiece conveying vehicle, and the stock unit, a receiver that receives a notification signal transmitted from the processing apparatus, and a control signal generating part that generates the control signal to be transmitted from the transmitter, wherein

the control signal generating part of the control unit generates the control signal to be transmitted from the transmitter of the control unit based on the notification signal received by the receiver of the control unit,

the transmitter of the control unit transmits the control signal generated by the control signal generating part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, and the stock unit,

the workpiece conveying part of the stock unit

conveys the workpiece carried out from the workpiece stocker to the workpiece support part of the automated workpiece conveying vehicle based on the control signal received by the receiver of the stock unit, and

the traveling mechanism of the automated workpiece conveying vehicle causes the automated workpiece conveying vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated workpiece conveying vehicle to convey the workpiece supported by the workpiece support part to the processing apparatus.

2. The conveyance system according to claim 1, wherein

the conveyance passage is set on an upper surface of the processing apparatus.

3. The conveyance system according to claim 1, wherein

the conveyance passage is configured by coupling a plurality of passage modules.

4. The conveyance system according to claim 1, wherein

the conveyance passage includes a leg part having a suction adhesion part that adheres to the processing apparatus by suction, and is fixed to the processing

apparatus by the suction adhesion part.

5. The conveyance system according to claim 1,
wherein

the processing apparatus has a conduit connecting
part to which conduits are connected or a door for
maintenance on a side surface.

6. The conveyance system according to claim 1,
further comprising:

an automated blade conveying vehicle including a
blade support part that supports a cutting blade used
when the workpiece is processed by the processing
apparatus, a traveling mechanism disposed on the blade
support part, and a receiver that receives a control
signal, the automated blade conveying vehicle traveling
on the conveyance passage, wherein

the stock unit further includes a blade conveying
part that conveys the cutting blade between a blade
stocker that houses the cutting blade to be supplied to
the processing apparatus and the automated blade
conveying vehicle,

the transmitter of the control unit further has a
function of transmitting the control signal to the
automated blade conveying vehicle,

the transmitter of the control unit transmits the

control signal generated by the control signal generating part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, the automated blade conveying vehicle, and the stock unit,

the blade conveying part of the stock unit conveys the cutting blade housed in the blade stocker to the blade support part of the automated blade conveying vehicle based on the control signal received by the receiver of the stock unit, and

the traveling mechanism of the automated blade conveying vehicle causes the automated blade conveying vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated blade conveying vehicle to convey the cutting blade supported by the blade support part to the processing apparatus.

7. The conveyance system according to claim 2, wherein

the conveyance passage is configured by coupling a plurality of passage modules.

8. The conveyance system according to claim 2, wherein

the conveyance passage includes a leg part having a suction adhesion part that adheres to the processing

apparatus by suction, and is fixed to the processing apparatus by the suction adhesion part.

9. The conveyance system according to claim 2, wherein

the processing apparatus has a conduit connecting part to which conduits are connected or a door for maintenance on a side surface.

10. The conveyance system according to claim 2, further comprising:

an automated blade conveying vehicle including a blade support part that supports a cutting blade used when the workpiece is processed by the processing apparatus, a traveling mechanism disposed on the blade support part, and a receiver that receives a control signal, the automated blade conveying vehicle traveling on the conveyance passage, wherein

the stock unit further includes a blade conveying part that conveys the cutting blade between a blade stocker that houses the cutting blade to be supplied to the processing apparatus and the automated blade conveying vehicle,

the transmitter of the control unit further has a function of transmitting the control signal to the automated blade conveying vehicle,

the transmitter of the control unit transmits the control signal generated by the control signal generating part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, the automated blade conveying vehicle, and the stock unit,

the blade conveying part of the stock unit conveys the cutting blade housed in the blade stocker to the blade support part of the automated blade conveying vehicle based on the control signal received by the receiver of the stock unit, and

the traveling mechanism of the automated blade conveying vehicle causes the automated blade conveying vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated blade conveying vehicle to convey the cutting blade supported by the blade support part to the processing apparatus.

11. The conveyance system according to claim 3, wherein

the conveyance passage includes a leg part having a suction adhesion part that adheres to the processing apparatus by suction, and is fixed to the processing apparatus by the suction adhesion part.

12. The conveyance system according to claim 3,

wherein

the processing apparatus has a conduit connecting part to which conduits are connected or a door for maintenance on a side surface.

13. The conveyance system according to claim 3, further comprising:

an automated blade conveying vehicle including a blade support part that supports a cutting blade used when the workpiece is processed by the processing apparatus, a traveling mechanism disposed on the blade support part, and a receiver that receives a control signal, the automated blade conveying vehicle traveling on the conveyance passage, wherein

the stock unit further includes a blade conveying part that conveys the cutting blade between a blade stocker that houses the cutting blade to be supplied to the processing apparatus and the automated blade conveying vehicle,

the transmitter of the control unit further has a function of transmitting the control signal to the automated blade conveying vehicle,

the transmitter of the control unit transmits the control signal generated by the control signal generating part of the control unit to the processing apparatus, the

automated workpiece conveying vehicle, the automated blade conveying vehicle, and the stock unit,

the blade conveying part of the stock unit conveys the cutting blade housed in the blade stocker to the blade support part of the automated blade conveying vehicle based on the control signal received by the receiver of the stock unit, and

the traveling mechanism of the automated blade conveying vehicle causes the automated blade conveying vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated blade conveying vehicle to convey the cutting blade supported by the blade support part to the processing apparatus.

14. The conveyance system according to claim 4, wherein

the processing apparatus has a conduit connecting part to which conduits are connected or a door for maintenance on a side surface.

15. The conveyance system according to claim 4, further comprising:

an automated blade conveying vehicle including a blade support part that supports a cutting blade used when the workpiece is processed by the processing

apparatus, a traveling mechanism disposed on the blade support part, and a receiver that receives a control signal, the automated blade conveying vehicle traveling on the conveyance passage, wherein

the stock unit further includes a blade conveying part that conveys the cutting blade between a blade stocker that houses the cutting blade to be supplied to the processing apparatus and the automated blade conveying vehicle,

the transmitter of the control unit further has a function of transmitting the control signal to the automated blade conveying vehicle,

the transmitter of the control unit transmits the control signal generated by the control signal generating part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, the automated blade conveying vehicle, and the stock unit,

the blade conveying part of the stock unit conveys the cutting blade housed in the blade stocker to the blade support part of the automated blade conveying vehicle based on the control signal received by the receiver of the stock unit, and

the traveling mechanism of the automated blade conveying vehicle causes the automated blade conveying

vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated blade conveying vehicle to convey the cutting blade supported by the blade support part to the processing apparatus.

16. The conveyance system according to claim 5, further comprising:

an automated blade conveying vehicle including a blade support part that supports a cutting blade used when the workpiece is processed by the processing apparatus, a traveling mechanism disposed on the blade support part, and a receiver that receives a control signal, the automated blade conveying vehicle traveling on the conveyance passage, wherein

the stock unit further includes a blade conveying part that conveys the cutting blade between a blade stocker that houses the cutting blade to be supplied to the processing apparatus and the automated blade conveying vehicle,

the transmitter of the control unit further has a function of transmitting the control signal to the automated blade conveying vehicle,

the transmitter of the control unit transmits the control signal generated by the control signal generating

part of the control unit to the processing apparatus, the automated workpiece conveying vehicle, the automated blade conveying vehicle, and the stock unit,

the blade conveying part of the stock unit conveys the cutting blade housed in the blade stocker to the blade support part of the automated blade conveying vehicle based on the control signal received by the receiver of the stock unit, and

the traveling mechanism of the automated blade conveying vehicle causes the automated blade conveying vehicle to travel on the conveyance passage based on the control signal received by the receiver of the automated blade conveying vehicle to convey the cutting blade supported by the blade support part to the processing apparatus.