



G00002

SPECIFICATION

Title of the Invention

MANUFACTURING APPARATUS WITH CLEANING MECHANISM
AND CLEANING METHOD

Field of the Invention

166166

The present invention refers to a manufacturing apparatus, such as production apparatus related to semiconductors or liquid crystals, working/assembling apparatus for parts and products related to multimedia such as optical disks, plasma displays or TV, and production apparatus related to packaging/processing of electronic parts in electric circuit boards, requiring a cleaner environment than general environments in the manufacturing of parts and products. Specifically, the present invention refers to a manufacturing apparatus including robot system wherein it is made possible to process workpieces, such as parts or products, at high quality by the provision of a cleaning mechanism for forming a clean space with very few of dust, unnecessary components and such others in the atmosphere, that is, cleaner environments (clean space) than general in the apparatus to execute various working/assembling operations incompatible with dust, unnecessary component substances or the like, and a cleaning method.

Background of the Invention

With a manufacturing apparatus for semiconductors/liquid crystals/electric circuit substrates or other precision products, only the presence of fine dust in air will greatly affects the quality performance of a product. Thus, manufacturing apparatus used in such manufacturing are placed in a so-called clean room in which dust in air are removed at a high level and serves for various processing.

A well-known clean room is so arranged as to maintain the cleanliness by taking a clean air into the room, for example, with the aide of a high efficiency particulate air filter (HEAPA filter) embedded in the ceiling and circulating it.

Such a clean room has the following problems.

(1) An enormous investment is required for the construction of a clean room not directly related to the manufacturing of parts or products.

(2) The operating maintenance cost of a clean room is enormous.

(3) Operationality is bad.

The problems (1) and (2) mentioned above directly leads to a rise in manufacturing cost. And generally, with a change in the type or manufacturing process of products, arrangement change, addition or removal of manufacturing apparatus is frequently performed. Especially on the change of a manufacturing line, the clean room must be naturally reconstructed, but it is extremely uneconomical to reconstruct the whole clean room for each slight modification in manufacturing line and moreover it is extremely wasteful to

design and build a clean room at each time in accordance with a modified manufacturing line.

And as another well-known cleaning device, there is a clean spatial passage device smaller in structure than a general clean room. By successively linking tubular, open-ended clean room units having a definite internal volume, this is provided with a required volume and arrangement shape and moreover constitutes a continuous and long clean spatial passage. This clean spatial passage device mainly includes two types. One is a scheme that a manufacturing apparatus is installed in the clean spatial passage and the other is a scheme that a manufacturing apparatus is installed in a general environment and connected the clean spatial passage and workpieces are uniquely carried over through the clean spatial passage to fulfil a predetermined processing operation.

It is considered that, if such a clean spatial passage device is employed, any modification of a manufacturing line can be coped with in a relatively simple and flexible manner only by a change in the arrangement of clean room units and the economic and temporal burdens accompanying the modification of a manufacturing line can be saved as compared with a general clean room. In fact, however, the provision or connection of individual manufacturing apparatus in or to the clean spatial passage brings about a portion of air to locally stay behind or contaminations to be accumulated due to a slight change in the air flowing state or pressure

distribution inside the clean space and accordingly the clean room must be redesigned, reconstructed and renewed in such a manner as to be adaptable to an new clean room in consideration of the volume or shape of the whole clean space including a cleaning device such as air filter for removing dust in the space and circulator fan for circulating the air flow, an air conditioner for regulating the temperature and humidity or the like. Thus, a long period of time is taken till the completion of work, and consequently there is a problem that the advantage expectable for clean room or spatial passage device is greatly reduced and not so great extent of effect is obtained.

Besides, with such a general clean room or a clean spatial passage device connecting clean room units, a wider space than the local space with the need for truly clean environments must be kept in a clean state and accordingly the downsizing or maintenance of the above cleaning device or air conditioner was restricted. Especially, when a clean atmosphere is needed only when processing a workpiece and no so clean environments are needed during the carriage of workpieces, there has been a strong demand for securing a further cleaner space in manufacturing and for reducing the manufacturing cost without a great scale of construction of a clean environmental plant such as clean room or clean space passage device as mentioned above and plant investment for the installation of the plant.

For the formation of an inexpensive clean space, it is

- 5 -

important to save the expenditure of management and maintenance for clean environments including the operating cost and maintenance cost, by contriving to minimize the frequency of replacing a high-performance filter such as HEPA filter used generally in a clean room or the like, an active-carbon absorption filter for removing a poisonous
5 component or the like, by reducing the consumed amount of clean gas such as air and nitrogen fed to the clean space, or by the downsizing or energy-saving of a motive equipment such as ventilation fan. At present, however, except a dust cleaning measure by using the existing high-performance filter mentioned above, there is no effective method for forming a clean atmosphere equal to or higher than the cleanliness of a high-
10 performance filter, for example, by using an inexpensive middle-performance filter and more positive technical means for recovering and removing a pollutant such as dust.

Summary of the Invention

15 The present invention aims to address or ameliorate one or more of the above problems, or to at least provide a useful alternative.

The present invention provides a manufacturing apparatus requiring a clear atmosphere for the processing of workpieces such as parts or products, comprising:

- a cabinet for dividing the apparatus interior and a general environment;
- 20 at least one of circulating means for circulating the atmosphere inside said cabinet through a filter or feed means for feeding a clean gas into said cabinet;
- detection means for detecting the level of cleanliness of the apparatus interior, and
- control means for controlling at least either one of said circulation means or said feed means in accordance with data on the level of cleanliness detected by said detection
- 25 means to maintain the level of cleanliness of the in-apparatus space.

According to such an arrangement, since the atmosphere in the apparatus divided by a cabinet from a general environment is circulated through a filter provided in the apparatus, the level of cleanliness in the closed space can be raised. And, since the manufacturing apparatus is made into a closest possible sealed structure with the aid of the
30 cabinet and a clean gas is fed in such a manner by supply means that the inner pressure inside the apparatus is a little more pressurized than general environments outside the

apparatus, the intrusion of pollutants such as dust from external environments of the apparatus can be prevented. And, since the gas resultant from the direct cleaning of the atmosphere of an out-of-apparatus general environment is fed to the apparatus interior, the pass life of the filter can be prolonged in leaps and bounds. And since the space inside the
5 apparatus is much smaller than the clean room, the apparatus interior can be freely made into a desired clean atmosphere by selecting the operating condition of a circulated ventilation amount determining the number of atmosphere circulation or a filter (selection of an HEPA filter or middle-performance filter according to the object).

And, since a manufacturing apparatus according to embodiments of the present
10 invention can be installed in general environments, a clean space can be secured without a great scale of construction of a clean environmental plant such as said clean room or clean spatial passage device connecting clean room units as mentioned above or a great sum of pant investment for the installation of a plant and an inexpensive and good quality working/assembling of parts or products can be implemented.

15 The present invention further provides a manufacturing apparatus requiring a clear atmosphere for the processing of workpieces such as parts or products, comprising:

an enclosure for dividing said workpiece and a general environment;

means for forming a clean gas in a line or curtain on the open surface of said enclosure and forming a clear local processing space enabling said workpiece to be
20 processed; and

mix means for mixing the vapor, mist, droplets or gas of a substance functioning to remove dust or unnecessary component matters into a clean gas.

The present invention also provides a manufacturing apparatus requiring a clear atmosphere for the processing of workpieces such as parts or products, comprising:

25 a cabinet for dividing the apparatus interior and a general environment; and

at least one of circulating means for circulating the atmosphere inside said cabinet through a filter or feed means for feeding a clean gas into said cabinet,

wherein a carrying-in preparatory chamber for removing unnecessary component matters adhered to said workpiece with said clean gas is additionally provided outside the
30 said cabinet; and

mix means for mixing the vapor, mist, droplets or gas of a substance functioning to

remove dust or unnecessary component matters into a clean gas is provided.

Brief Description of the Drawings

5 FIG. 1 is a schematic drawing of a manufacturing apparatus with a cleaning mechanism according to Embodiment 1 of the present invention;

 FIG. 2 is a schematic drawing of an aspect of manufacturing apparatus with a cleaning mechanism according to Embodiment 2 of the present invention;

 FIG. 3 is a schematic drawing of another aspect of manufacturing apparatus with a
10 cleaning mechanism according to Embodiment 2 of the present invention;

 FIG. 4 is a schematic drawing of a manufacturing apparatus with a local cleaning mechanism according to

Embodiment 3 of the present invention;

FIG. 5 is a schematic drawing of another aspect of manufacturing apparatus with a cleaning function, equipped with means for controlling the cleaning mechanism according to Embodiment 4 of the present invention;

FIG. 6 is a schematic drawing of an aspect of structure of the local cleaning mechanism in a manufacturing apparatus with a cleaning mechanism according to Embodiment 5 of the present invention;

FIG. 7 is a schematic drawing of another aspect of structure of the local cleaning mechanism in a manufacturing apparatus with a cleaning mechanism according to Embodiment 5 of the present invention;

FIG. 8 is a schematic drawing of still another aspect of structure of the local cleaning mechanism in a manufacturing apparatus with a cleaning mechanism according to Embodiment 5 of the present invention;

FIG. 9 is a schematic drawing of yet another aspect of structure of the local cleaning mechanism in a manufacturing apparatus with a cleaning mechanism according to Embodiment 5 of the present invention;

FIG. 10 is a schematic drawing of a manufacturing apparatus with a cleaning mechanism according to Embodiment 6 of the present invention;

FIG. 11 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 7 of the present invention;

FIG. 12 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 7 of the present invention;

FIG. 13 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 8 of the present invention;

FIG. 14 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 9 of the present invention;

FIG. 15 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 10 of the present invention;

FIG. 16 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 11 of the present invention;

FIG. 17 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 12 of the present invention;

FIG. 18 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 13 of the present invention;

FIG. 19 is a schematic drawing of a robot system with a cleaning mechanism according to Embodiment 14 of the present invention;

FIG. 20 is a schematic perspective view of a wire bonding apparatus with a cleaning mechanism in practical use of an embodiment of the present invention;

FIG. 21 is a graph showing the cleaning performance (measured result of dust concentration) of a wire bonding apparatus with a cleaning mechanism in FIG. 20;

FIG. 22 is a graph showing the cleaning performance (measured result of dust concentration) of a wire bonding apparatus with a cleaning mechanism in FIG. 20; and

FIG. 23 is a graph showing the cleaning performance (measured result of dust concentration) of a wire bonding apparatus with a cleaning mechanism in FIG. 20.

Description of the Preferred Embodiments

Referring to the drawings, embodiment of the present invention will be described. Incidentally, to like arrangements are like symbols assigned and the description thereof will be omitted.

(Embodiment 1)

FIG. 1 shows the outline of Embodiment 1 of the present invention. This manufacturing apparatus is provided with a cleaning device for cleaning the inner atmosphere thereof.

That is, the interior of the apparatus and the general environments are divided with a cabinet 1 of the apparatus and the atmosphere inside the apparatus is passed through a filter 3, cleaned and circulated by using a fan 2 as motive source. To be specific, after passing the upper space 5 of the apparatus and rectified by a rectification plate 6, the atmosphere cleaned through a filter 3 is lowered through an operating space 9 in which a processing operation section 7

executes the processing of a workpiece 8. After rectified through a rectifying plate 16, the atmosphere processed across the workpiece 8 is led to the flow passage 13. The atmosphere containing dust generated by the operation of the processing operation section 7 or other machinery 10, 11 is returned through the flow passage 12 and the above flow passage 13 to the filter 3. In this way, the processing space in the apparatus becomes a clean state all the time. In order that unnecessary matters such as dust generated by wear of mechanical operation of the processing operation section 7 does not fall on and is not adhered to a workpiece 8, the suction position of the flow passage 12 is arranged downstream of the gas flow of the processing operation section 7.

And to make the interior of the apparatus into a slightly pressurized state, prevent the intrusion of unnecessary matters in a general environment and stably maintain the atmosphere inside the apparatus during the processing, a clean gas passed from the gas feed pipe 14 through the cleaning filter 15 is fed.

According the above arrangement, since the space inside the apparatus is much smaller than a general clean room, a high level of cleanliness is obtained in a short time on increasing the circulation wind amount of the atmosphere and a desired clean state can be created by controlling this circulation wind amount. And by arranging a structure in consideration of the state of a gas flow, a cleaner atmosphere can be formed around the workpiece 8.

An operator 4 has only to monitor the processing in a general environment.

(Embodiment 2)

The outline of Embodiment 2 of the present invention is shown in FIG. 2. According to the arrangement of Embodiment 2, a case where no cleaning mechanism is mountable or a case where it is desired to add a cleaning mechanism by reconstruction for an existing manufacturing apparatus having no cleaning mechanism originally provided therein can be coped with.

According to the scheme of FIG. 2, showing a case where a cleaning unit 17 is mounted to the main manufacturing apparatus body (cabinet 1) for an existing manufacturing apparatus having no cleaning mechanism provided therein, this unit can be easily mounted by means of a fitting jig 17A and a function similar to that of FIG. 1 can be obtained. Attached to the cleaning unit 17 are a fan 2, a filter 3, a rectification plate 6, a gas feed pipe 14, a cleaning filter 15 and a rectification plate 18. With the aide of the rectifying plate 18, the atmosphere passed through the flow passage 12 and the flow passage 13 are rectified and returned to the fan 2.

The scheme of FIG. 3 is useful for a case where the cleaning unit 17 mentioned above cannot be mounted to the main manufacturing apparatus body, or a case where it is desired to deal with a plurality of manufacturing apparatus through a unit of cleaning device or the like. Attached to the cleaning

device 23 are a fan 2, a filter 3, a gas feed pipe 14 and a cleaning filter 15, connected to the upper space 5 of the apparatus via a gas introduction pipe 21 and a ventilation connection section 22 and connected to a flow passage 12 and a flow passage 13 via a gas introduction pipe 20 and a ventilation connection section 19.

Like this, by attaching the cleaning unit 17 to an existing manufacturing apparatus in reform coping or by connecting a plurality of manufacturing apparatus to the independent concentration-controlled cleaning device 23, the arrangement modification accompanying a change in manufacturing apparatus or addition or removal due to the introduction of a new apparatus is implemented rapidly and at low cost. And, if the fitting structure of the ventilation connection sections 19 and 22 in the cleaning device 23 are universalized, the cleaning device 23 used in the former manufacturing apparatus can be jointly used.

(Embodiment 3)

The outline of Embodiment 3 of the present invention is shown in FIG. 4. With Embodiment 3, in addition to a cleaning mechanism for making the whole apparatus interior into a clean atmosphere, the further provision of a local cleaning mechanism for making only the processing space for processing a workpiece into a cleaner atmosphere enables the local cleaning space with much higher level of cleanliness to be formed than the external environment. Needless to say, the cleanliness of the local work space section for a case where

this local cleaning mechanism is not operated depends on the capability of the cleaning mechanism to clean the whole apparatus interior. Since the manufacturing apparatus with this local cleaning mechanism makes only the minimum necessary processing space into a highly clean atmosphere, a workpiece can be processed by using a cheaper clean space than a high-performance clean room.

Besides, with Embodiment 3, by using the gas, vapor or fine mist of a substance functioning to physically or chemically remove dust or unnecessary matters in a manufacturing apparatus, mixing this in the clean gas fed to the apparatus interior to collide with and contact the atmosphere inside the apparatus, and recovering and discharging unnecessary matter therein to the outside, dust or unnecessary matters in the manufacturing apparatus can be removed more effectively.

In FIG. 4, to make the local space near a workpiece 8 into a highly clean atmosphere, the clean gas produced by the suction in a suction device 24 and filtration in a filter 25 is blown off from the blowoff nozzle 26. Most of the blown off clean gas is sucked in by a suction nozzle 27 and exhausted to the apparatus exterior by the power of a exhauster 28. By dint of a curtain of clean gas formed between the blowoff nozzle 26 and the suction nozzle 27, the workpiece is enveloped with a cleaner atmosphere than the whole manufacturing-apparatus interior. That is, an atmosphere locally different in cleanliness is produced inside

the manufacturing apparatus. Alternatively, by use of cylinder feed in place of the suction device 24, a clean gas may be fed. Furthermore, the gas exhausted from the exhauster 28 can be collected, passed through a filter again and reused.

Alternatively, with the clean gas fed from the suction device 24 and passed through the filter 25, the gas or vapor of a substance functioning to remove dust or unnecessary matters and the gas, vapor or fine mist produced from a mist generator 29 are mixed and fed through the blowoff nozzle 26 to the manufacturing-apparatus interior. After brought into contact with dust or unnecessary matters in the manufacturing apparatus, this gas mixture is sucked into the suction nozzle 27 and exhausted outside the apparatus. A much higher cleanliness of atmosphere can be obtained than obtained by using only the clean gas.

(Embodiment 4)

The outline of Embodiment 4 of the present invention is shown in FIG. 5. By means of a detection sensor 31a and 31b in a manufacturing apparatus, conditions such as cleanliness, concentration, temperature and humidity of individual space portions in a manufacturing apparatus where these sensors are disposed are detected and conveyed to a detection instrument 32. The actual atmosphere detected by means of this detection instrument 32 and a desired state to be retained for the processing of a workpiece 8 are compared with each other by means of a control device 33, the operating condition is found in such a manner that the actual state approaches a desired

state on the basis of the result of mutual differences, and the operating information is conveyed to flow rate regulating valve 34a, 34b and 34c for controlling a fan 2, a suction device 24, an exhauster 28 and the flow rate of a gas.

Like this, by controlling the fan 2, the suction device 24, the exhauster 28 and the flow rate regulating valve 34a, 34b and 34c by the control device 33, the atmosphere in the apparatus can be retained to a desired state. Incidentally, the detection instrument 32 or the control device 33 may be located outside the manufacturing apparatus.

(Embodiment 5)

The outline of Embodiment 5 of the present invention is shown in FIGs. 6, 7, 8 and 9. In Environment 5, the structure of a cleaning mechanism raising the cleanliness of the local space is proposed.

FIG. 6 shows the fundamental structure of the cleaning mechanism of a manufacturing apparatus according to the present invention.

A workpiece 8 is surrounded by a support plate 35 and partition plates 36 and 37, while the top face portion of the workpiece 8 is spatially shut off with a gas curtain produced by using the clean gas fed from the feed pipe 38 between a blowoff valve 39a and the a suction nozzle 40a. The clean gas sucked into the suction nozzle 40a is exhausted through the exhaust pipe 42. And, the feed amount and exhaust amount of the clean gas are regulated by means of flow rate regulating valves 43a and 43b.

According to the above arrangement, a clean atmosphere is obtained in the space 41 above the workpiece 8. This structure is useful for a case where unnecessary matters are generated in a small quantity from the workpiece 8 itself or from the processing operation section 7.

The structure of a cleaning mechanism according to the present invention, shown in FIG. 7 is based on that of FIG. 6 and is characterized in that the atmosphere above the workpiece 8 can be replaced only in the required amount. By adjusting the feed amount and exhaust amount of a clean gas, a stable flow of clean atmosphere can be formed. To be specific, by having a second partition plate 44 provided inside the partition plate 36, feeding the required amount of clean gas from the space between the partition plates 36 and 44 through the feed port 45 and 46 and exhausting the atmosphere of the space 41 above the workpiece 8 from the exhaust port 47 provided inside the second partition plate 44, the flow of clean gas in the space 41 can be made into a stable flow and a high clean level of atmosphere can be created inside the space 41. And, the feed amount and exhaust amount of a clean gas can be regulated by means of flow rate regulating valves 43c, 43d, 43e, 43f and 43g.

And, these structures shown in FIGs. 6 and 7 are ones in which only one upper side is shut off by using a gas curtain and useful for a case where the carrying-in, carrying-out or processing of a workpiece is performed from the top-face side.

As with the apparatus shown in FIG. 7, by making the

space 41 into a stable flow of atmosphere, the temperature on the whole surface of a workpiece 8 can be made more uniform and a more uniform heating is enabled. Besides, in one example of bonding device in the manufacturing apparatus, a phenomena that the shape of an initial ball (ball formed by the melting of a wire used for wire pointing) becomes instable or an initial ball is formed or is not formed can be prevented which occurs on the generation of a turbulent flow in dependence of the position of the atmosphere of the space 41.

Furthermore, as shown in FIGs. 8 and 9 of the present invention, if cleaning structures, such as structure opened in two side faces and structure opened in three faces comprising the top face and two side faces, are employed in which several shut-off methods by using gas curtains are combined, a wide variety of processing operations of a workpiece from many sides can proceed while a clean space is formed locally by adjusting and controlling the flow of individual nozzles.

In FIG. 8, by feeding a clean air to a workpiece 8 from the feed pipe 38 via a rectification plate 48 and spatially shutting off the space 41 above the workpiece 8 with the gas curtain produced between the blowoff nozzle 39b and the suction nozzle 40b, a clean atmosphere is obtained above the workpiece 8. And, the feed amount and exhaust amount of the clean gas are regulated by means of flow rate regulating valves 43h, 43i and 43j.

In FIG. 9, by using three sides of gas curtains produced between the blowoff nozzles 39c, 39d and the suction nozzle

40b, 40c, a clean atmosphere is obtained above the workpiece 8. And, the feed amount and exhaust amount of clean gases from individual nozzles 39c, 39d, 40b and 40c are regulated by means of flow rate regulating valves 43k, 43l, 42m and 43n. (Embodiment 6)

The outline of Embodiment 6 of the present invention is shown in FIG. 10. In Embodiment 6, by having a cleaning preparatory chamber provided, removing unnecessary matters adhered to a workpiece therein and preventing unnecessary matters from intruding into the manufacturing apparatus, the manufacturing-apparatus interior can be kept in a clean state at all times. Beside, in carrying operation of a workpiece between a general environment and a manufacturing apparatus or the like, a fault that a workpiece is likely to be contaminated on account of installation of the manufacturing apparatus in a general environment can be remedied.

In FIG. 10, to process workpieces 8a in the manufacturing apparatus 49, first, a door 54a is opened and a cassette 51a accommodating workpieces 8a is carried into a carrying-in preparatory chamber 53a capable of introducing a clean gas generated in the cleaning chamber 23. By using a cleaned gas blown off from a blowoff nozzle 55a in the carrying-in preparatory chamber 53a, the unnecessary matters adhered in a general environment to the workpieces 8a are removed. And at the same time, by opening the door 54a to allow the atmosphere of the general environment intruded into the carrying-in preparatory chamber 53a to be exhausted from the suction

nozzle 56a, the atmosphere is replaced to make the carrying-in preparatory chamber 53a interior into a clean atmosphere. The exhausted atmosphere enters the cleaning device 23, passes through a filter 3 again, changes into a cleaned gas and is circulated and reused. To be carried into the manufacturing apparatus 49 filled with a clean atmosphere, workpieces 8a', carried into the carrying-in preparatory chamber 53a filled with a clean atmosphere, are transferred after opening the door 57a. Workpieces 8a' are transferred one by one, and when the transfer ends, the door 57a closes. The workpieces 8 placed on a support 58 are processed by means of a processing device 59 in a clean atmosphere composed of a cleaned air fed from the clean device 23 through a rectification plate 60. The atmosphere in the manufacturing apparatus 49 is exhausted to the cleaning device 23 via a rectification plate 61 and reused. On the completion of processing, a door 57b opens and the workpieces 8 are transferred to a carrying-out preparatory chamber 53b in which a clean atmosphere has already been retained. On the completion of transfer, the door 57b closes. In the carrying-out preparatory chamber 53b, the unnecessary matters adhered due to processing onto the workpieces 8b' are removed by using a cleaned gas blown off from a blowoff nozzle 55b. In carrying out the workpieces 8b' from the carrying-out preparatory chamber 53b to a general environment, the carrying-out preparatory chamber interior touches the atmosphere of the general environment on opening a door 54b and accordingly unnecessary matters in the general environment

intrude into the carrying-out preparatory chamber 53b. To remove these unnecessary matters, the atmosphere in the carrying-out preparatory chamber 53b is sucked in by a suction nozzle 56b and exhausted outside the carrying-out preparatory chamber 53b. The exhausted atmosphere enters the cleaning device 23, passes through a filter 3, changes into a cleaned gas again and is circulated and reused.

(Embodiment 7)

The outline of Embodiment 7 of the present invention is shown in FIGs. 11 and 12. FIGs. 11 and 12 are schematic drawings of a robot system with the cleaning mechanism in Embodiment 7. Together with a workpiece storage section 82 and a manufacturing apparatus 83, this robot system 81 is provided in a general environment.

The robot system 81 comprises a main body 91 and an arm 92. To the arm 92, a retainer section 94 for retaining a workpiece 8, a blowoff nozzle 95 and a suction nozzle 95 are fixed. The arm 92 is moved by arm drive means such as a servo motor 93 in such a manner as that a workpiece 8 is transferred to a processing position 85 in front of the manufacturing apparatus 83. The retainer section 94 is so arranged as to retain a workpiece 8 between two or more fingers or by vacuum suction.

The blowoff nozzle 95 is so arranged as to blow off a clean gas fed through a flow passage 97 from the blowoff port 98 thereof. The blowoff port 98 is a larger opening than the workpiece 8 as if covering and concealing it. Or is so

formed, for example, as to have a longer diameter than the long side of the workpiece 8. As clean gas, one fed from the cylinder, one made clean by the filtering of the gas taken in from a general environment, one made clean by the filtering after taking in a clean gas blown off from the blowoff nozzle 95 and such others are utilizable.

When the clean gas taken from a cylinder is utilized, the absence of a suction nozzle 96 is allowable but the presence is preferable.

When the gas taken from a general environment is made into a clean gas, the positioning of a suction nozzle 96 is not particularly limited. In the devices of FIGs. 11 and 12, a suction nozzle 96 is provided in such a manner that a suction port 99 faces toward the blowoff port 99 of the blowoff nozzle 95, but may be provided at any other positions. However, it is more effective for a radical prolongation of the pass life and promotion of the cleanliness of a filter 3 to take in the clean gas blown off from the blowoff nozzle 95, and feed it to the blowoff nozzle 95 after passing through a filter 3 than to make the gas taken in from a general environment into a clean gas. The suction port 99 is a larger opening than the workpiece 8 as if covering and concealing it. Or is so formed, for example, as to have a longer diameter than the long side of the workpiece 8.

To take in either the gas of a general environment or the gas blown off from the blowoff nozzle 95 to make a clean gas, a cleaning device 23 is provided on the main body 91 and the

robot system is so constructed as to circulate the atmosphere around a workpiece 8 by sucking it in from the suction nozzle 96 with the aid of a fan 2 as power source, making it into a clean atmosphere after passing through the filter 3 and blowing it off from the blowoff nozzle 95. The gas sucked in from the suction nozzle 96 by action of the fan 2 passes the flow passage 100, is filtered through the filter 3 and becomes a clean gas freed from dust or unnecessary component matters. This clean gas is fed to the blowoff nozzle 95 through the flow passage 97 and blown off from the blowoff port 98 of the nozzle 95. The clean gas blown off traverses the processing position (working space) 85 in which a workpiece 8 kept at a retainer section 94 is processed. The atmosphere containing dust or the like generated by the operation of the processing operation section 87 or the like is exhausted to a general environment, or is sucked in from the suction nozzle 96 and returned to the filter 3 through the flow passage 100. In this way, the processing space for a workpiece 8 turns into a clean state at the operating time of the fan 2. When the need for retaining the article to be processed 8 in a clean gas disappears, the fan 2 is stopped and the workpiece 8 is exposed to a general environment. Since the periphery of the workpiece 8 is a much smaller space than a general clean room, an increase in the amount of circulating atmosphere ventilation leads to a high level of cleanliness in a short time, or control of this circulating ventilation enables a desired clean atmosphere to be created. The circulating

ventilation is regulated, e.g., by controlling the ON/OFF or opening of the valves 43o and 43p.

The flow passages 97 and 100 also serve for fixation means for fixing the nozzles 95 and 96 to the arm 92, respectively, but nozzles 95 and 96 may be fixed to the arm 92 by fixation means provided separately from the flow passages.

And, when both rectification plates 101 and 102 are provided either upstream of the blowoff port 98 of the nozzle 95 or downstream of the suction port of the nozzle 96, the gas is rectified by means of the rectification plates 101 and 102 and a stable flow can be created.

Though not shown, the main body 91 is provided with control means for controlling the arm drive means. And, as shown in FIG. 12, the retainer section 94 is faced toward the workpiece storage section 82 moving an arm 92, is extended or rotated, if necessary, to reach a workpiece 8, and after holding the workpiece 8, contracted or reversely rotated to hold the workpiece 8 in the space between the nozzles 95 and 96. If necessary, after the fan 2 is actuated and the gas surrounding the workpiece 8 is sucked in from the nozzle 96 and cleaned through the filter 3, a clean gas is blown off from the nozzle 95, envelopes the workpiece 8 and separates it from the external atmosphere. In this separation state, or in a state of exposure to a general environment atmosphere, the arm 92 is moved and positioned at the processing position 85 as shown in FIG. 11, then the workpiece 8 is processed in the processing operation section 87 of the manufacturing apparatus

83. During this processing, by actuating the fan 2 to produce the relevant separation state, the workpiece 8 can be processed at high quality in a clean atmosphere. After the processing, the workpiece is transferred to the next manufacturing apparatus or the workpiece storage section in the relevant separation state or in a state of exposure to the atmosphere of a general environment. In order that unnecessary matters such as dust generated by wear of mechanical operation of the processing operation section 87 does not fall on and stick to the workpiece 8, the nozzles 95 and 96 are so arranged under consideration of the state of a gas flow from the position of the blowoff port 98 of the blowoff nozzle 95 and the suction port 99 of the suction nozzle 96 that the processing operation section 87 comes downstream of a gas flow, and a clean atmosphere can be formed.

A clean gas to be fed for creating the local clean space enveloping a workpiece 8, it is preferable to provide nitrogen gas or air. When feeding nitrogen gas as a clean gas, the local clean space enveloping a workpiece 8 can be made into the inert atmosphere. Alternatively, when feeding air as a clean gas, the cost can be saved.

The intrusion of unnecessary matters, such as dust, in a general environment can be prevented by considerations of such a feed amount of clean gas or such a nozzle structure that the atmosphere surrounding a workpiece 8 does not involve the external atmosphere around the above atmosphere. For this

purpose, a clean gas passed through the cleaning filter 15 from the gas feed pipe 14 is fed by means of suction device 24. This feed amount is regulated, e.g., by controlling the ON/OFF or opening of the valve 43q. If the flow of the atmosphere enveloping a workpiece 8 is in an adequate state, the intrusion of unnecessary matters such as in a general environment can be better prevented and the atmosphere of the processing space during the processing can be stably retained.

Since the space surrounding a workpiece 8 is much smaller than the clean room, in according with the operating conditions of circulating ventilation amount determining the number of circulating times of the atmosphere or the purpose of a filter (high-performance filter (HEPA filter), middle-performance filter or activated charcoal absorption filter for the removal of poisonous components is selected according to purposes), the surroundings of the workpiece 8 can be freely made into a desired clean atmosphere. And the replacement frequency of a filter can be minimized, the used amount of a clean gas, such as air and nitrogen gas, to be fed to the clean space surrounding a workpiece can be reduced or the downsizing or energy-saving of motive facilities can be accomplished.

Meanwhile, using an inexpensive, middle-performance filter, there is a method capable of forming a clean atmosphere of not lower level than that of a high-performance filter by using an inexpensive middle-performance filter. For example, the gas, vapor or fine mist of a substance

functioning to physically and chemically remove dust or unnecessary matters in the atmosphere surrounding a workpiece 8 is mixed into the clean gas fed to envelop the atmosphere surrounding the workpiece 8 and brought into collision against/contact with the atmosphere surrounding the workpiece 8, so that unnecessary matters in the relevant atmosphere can be collected and exhausted outside from the surroundings of the workpiece 8. In this case, dust or unnecessary matters in the atmosphere surrounding a workpiece 8 can be more effectively removed. Specifically, in Figs, 11 and 12, with the clean gas fed from the suction device 24 and passed through the filter 15, the gas or vapor of a substance functioning to remove dust or unnecessary matters and the gas, vapor or fine mist produced from a mist generator 29 are mixed and fed through the blowoff nozzle 95 to envelope the workpiece 8. After brought into contact with dust or unnecessary matters around the workpiece 8 this gas mixture is sucked into the suction nozzle 96 and exhausted outside the workpiece 8. A much higher cleanliness of atmosphere can be obtained than obtained by using only the clean gas.

(Embodiment 8)

The outline of Embodiment 8 of the present invention is shown in FIG. 13. In addition to the arrangement of Embodiment 7, a robot system according to Embodiment 8 further comprises the provision of a clean gas curtain created in such a manner as to envelope the space between the blowoff nozzle 95 and the suction nozzle 96 cylindrically.

That is, as shown in FIG. 13, the blowoff nozzle 95 has blowoff nozzles 39a, 39b for a gas curtain provided at the brim of the blowoff port 98 and is so arranged as to feed a clean gas from the feed pipe 38 branched from the flow passage 97 to the nozzles 39a, 39b and allow a clean gas to blow off therefrom. On the other hand, the suction nozzle 96 has suction nozzles 40a, 40b for a gas curtain provided at the brim of the suction port 99 and is so arranged as to join the sucked gas to the flow in the flow passage 100 from the blowoff pipe 42.

With Embodiment 8, since most of clean gas blown off from the nozzles 39a, 39b is so arranged as to be sucked from the nozzles 40a, 40b, dust or unnecessary matters in the atmosphere of a general environment is unlikely to mix in the clean gas blown off from the blowoff port 98 and directly enveloping a workpiece 8, a local clean space can be formed at a much higher level of cleanliness than the exterior environment.

In FIG. 13, the feed pipe 38 may not be branched from the flow passage 97 but may be used as a feed passage for feeding that clean gas to the blowoff nozzles 39a, 39b which is produced by filtering the gas sucked in from a general environment with the aide of the suction device, or the exhaust pipe 42 may be used as a flow passage for exhausting that gas outside which is sucked in from the suction nozzles 40a, 40b instead of join the sucked gas to the flow of the flow passage 100.

Alternatively, in place of a suction device, a clean gas may be fed by the cylinder feed. Furthermore, the gas exhausted with the aide of an exhaust device can be reused after collected and made into a clean gas by filtering.
(Embodiment 9)

The outline of Embodiment 9 of the present invention is shown in FIG. 14. In place of the blowoff nozzle 95 and suction nozzle 96 of Embodiment 7, a robot system according to Embodiment 9 has a hood 103 fixed to the arm 92 in such a manner as to cover up the retainer section 94 and is so constructed that the clean gas made clear after the suction from a general environment and passing through a filter by means of a suction device 24 is blown off toward the atmosphere of a general environment from an opening portion 103a of the hood 103. And, the retainer section 94 is made to penetrate a rectification plate 104.

The hood 103 comprises a opening portion 103a larger than a workpiece 8, a housing space 103b for housing a workpiece 8 and a blowoff port 103c, while the workpiece 8 is retained in the housing space 103b of the hood by a retainer section 94. The opening portion 103a has such a size as to cover and conceal the workpiece 8, e.g., is so formed as to have a longer diameter than the long side of the workpiece 8.

The retainer section 94 is extended outside from the housing space 103b of the hood 103 and if necessary, rotated to reach a workpiece 8 and hold the workpiece 8 (in FIG. 14, designated with a one-point chain line), then contracted or

reversely rotated to house the workpiece 8 in the housing space 103b of the hood 103. This structure is useful for cases where a small amount of dust or unnecessary matters is generated from a workpiece 8 itself or a processing operation section 87, and moreover simple. The feed amount of a clean gas is regulated, e.g., by controlling the ON/OFF and opening of valves 43o, 43p.

(Embodiment 10)

The outline of Embodiment 10 of the present invention is shown in FIG. 15. In addition to the arrangement of Embodiment 9, a robot system according to Embodiment 10 further comprises clean gas curtain generation means for generating a clean gas curtain provided in such a manner as to block the opening portion 103a of a hood 103, a partition plate 44 provided in the housing space 103b of the hood, a blowoff port 103c provided between the hood 103 and the partition 44 and a suction port 103d between the partition plates 44 and 44.

The clean gas curtain generation means has a blowoff nozzle 39c for a gas curtain provided at the brim of the opening portion 103a of the hood and a suction port 40c for a gas curtain. The operation of fan 2 is so arranged as to feed a clean gas through a filter 3 from the feed pipe 38 to the nozzle 39c and the blowoff port 103c, from which the clean gas is blown off, and as to suction a gas from the nozzle 40c and the suction port 103d.

With Embodiment 10, since most of clean gas blown off

from the nozzle 39c is so arranged as to be sucked from the nozzles 40c, dust or unnecessary matters in the atmosphere of a general environment is unlikely to mix in the clean gas blown off from the blowoff port 103c and directly enveloping a workpiece 8, a local clean space can be formed at a much higher level of cleanliness. The clean gas blown off from the blowoff port 103c and directly enveloping a workpiece 8 is sucked in from the suction port 103d. The sucked gas passes through a filter 3 to make a clean gas again and is blown off from the nozzle 39c and the blowoff port 103c. The feed amount of a clean gas is regulated, e.g., by controlling the ON/OFF and opening of valves 43c, 43d, 43e, 43f and 43g.

To the blowoff port 39c in FIG. 15, instead of a clean gas fed from the feed pipe 38, a clean gas, produced after the gas sucked from a general environment by means of a suction device 24 is passed through a filter 15, may be fed, or the gas sucked from the suction nozzle 40c may be exhausted outside by means of an exhauster without joined to the gas sucked from the suction port 103d.

Alternatively, in place of a suction device, a clean gas may be fed by the cylinder feed. Furthermore, the gas exhausted with the aide of an exhaust device can be reused after collected and made into a clean gas by filtering.

In comparison with Embodiment 9, Embodiment 10 can stabilize the flow of a clean gas in the housing space 103b and can create a highly clean atmosphere in the housing space 103b. By filling the housing space 103b with a stable flow of

atmosphere, the temperature can be more uniform on the whole surface of a workpiece 8 and a uniform heating can be made. Thus, a phenomenon of an initial ball to become unstable in shape or to be formed or not formed can be prevented which takes place when there is a difference in the turbulence of a flow in dependence on the position of the atmosphere in the space 103b, for example, for the bonding processing.

(Embodiment 11)

The outline of Embodiment 11 of the present invention is shown in FIG. 16. In addition to the arrangement of Embodiment 7, a robot system according to Embodiment 11 further comprises detection means for detecting the concentration of dust or unnecessary component matters in the atmosphere enveloping a workpiece 8 or the temperature or humidity and control means with function to control cleaning means at a desired concentration, temperature, humidity and cleanliness.

As shown in FIG. 16, through detection sensor 31a provided in the space between the nozzles 95 and 96, circumstances such as cleanliness, concentration, temperature and humidity of the respective space portions in which these are disposed are communicated to detection equipment 32 and the actual atmosphere detected with this detection equipment 32 and a desired state maintained for the processing of a workpiece 8 are mutually compared by control means 33. Based on the differences, the operating conditions for an approach of the actual state to a desired state are found and the

operation information is so arranged as to be communicated to a fan 2, a flow rate regulating valves 43o, 43p and 43q for regulating the flow of a gas and the suction device 24. Incidentally, the detection equipment 32 or the control device 33 may be provided outside the main body 91.

According to Embodiment 11, the local clean space enveloping a workpiece 8 can be approached to a desired state and the processing can be made more appropriate.

(Embodiment 12)

The outline of Embodiment 12 of the present invention is shown in FIG. 17. In addition to the arrangement of Embodiment 8, a robot system according to Embodiment 12 further comprises detection means for detecting the concentration of dust or unnecessary component matters in the atmosphere enveloping a workpiece 8 or the temperature or humidity and control means with function to control cleaning means at a desired concentration, temperature, humidity and cleanliness.

As shown in FIG. 17, through detection sensor 31a provided in the space between the nozzles 95 and 96, circumstances such as cleanliness, concentration, temperature and humidity of the respective space portions in which these are disposed are communicated to detection equipment 32 and the actual atmosphere detected with this detection equipment 32 and a desired state maintained for the processing of a workpiece 8 are mutually compared by control means 33. Based on the differences, the operating conditions for an approach

of the actual state to a desired state are found and the operation information is so arranged as to be communicated to a fan 2, a flow rate regulating valves 43o, 43p and 43q for regulating the flow of a gas and the suction device 24. Incidentally, the detection equipment 32 or the control device 33 may be provided outside the main body 91.

According to Embodiment 12, the local clean space enveloping a workpiece 8 can be approached to a desired state and the processing can be made more appropriate.

(Embodiment 13)

The outline of Embodiment 13 of the present invention is shown in FIG. 18. In addition to the arrangement of Embodiment 9, a robot system according to Embodiment 13 further comprises detection means for detecting the concentration of dust or unnecessary component matters in the atmosphere enveloping a workpiece 8 or the temperature or humidity and control means with function to control cleaning means at a desired concentration, temperature, humidity and cleanliness.

As shown in FIG. 18, through detection sensor 31a provided in the housing space 103b of the hood 103, circumstances such as cleanliness, concentration, temperature and humidity of the respective space portions in which these are disposed are communicated to detection equipment 32 and the actual atmosphere detected with this detection equipment 32 and a desired state maintained for the processing of a workpiece 8 are mutually compared by control means 33. Based

on the differences, the operating conditions for an approach of the actual state to a desired state are found and the operation information is so arranged as to be communicated to a flow rate regulating valves 43o, 43p and 43q for regulating the flow of a gas and the suction device 24. Incidentally, the detection equipment 32 or the control device 33 may be provided outside the main body 91.

According to Embodiment 13, the local clean space enveloping a workpiece 8 can be approached to a desired state and the processing can be made more appropriate.

(Embodiment 14)

The outline of Embodiment 14 of the present invention is shown in FIG. 19. In addition to the arrangement of Embodiment 10, a robot system according to Embodiment 14 further comprises detection means for detecting the concentration of dust or unnecessary component matters in the atmosphere enveloping a workpiece 8 or the temperature or humidity and control means with function to control cleaning means at a desired concentration, temperature, humidity and cleanliness.

As shown in FIG. 19, through detection sensor 31a provided in the housing space 103b of the hood 103, circumstances such as cleanliness, concentration, temperature and humidity of the respective space portions in which these are disposed are communicated to detection equipment 32 and the actual atmosphere detected with this detection equipment 32 and a desired state maintained for the processing of a

workpiece 8 are mutually compared by control means 33. Based on the differences, the operating conditions for an approach of the actual state to a desired state are found and the operation information is so arranged as to be communicated to a fan 2, a flow rate regulating valves 43c, 43d, 43e, 43f, 43g and 43q for regulating the flow of a gas and the suction device 24. Incidentally, the detection equipment 32 or the control device 33 may be provided outside the main body 91.

According to Embodiment 14, the local clean space enveloping a workpiece 8 can be approached to a desired state and the processing can be made more appropriate.

<Experimental example>

FIG. 20 is a perspective view of a wire bonding apparatus with clean unit to which the present invention is applied in practice. In FIG. 20, Numerals 62 and 63 denote a fan for a clean unit and an HEPA filter for dust collection, respectively. Under operating conditioned controlled, the fan 6 circulates the atmosphere of the whole apparatus interior to create a clean air. This clean air passes through an introducing section 64 provided in the top of the apparatus, is rectified through a rectification plate 65 and lowers through the space 66 for the bonding processing. In this bonding processing space 66, there are a processing support plate 67 heated at 300°C and a workpiece of circuit substrate 68 placed thereon are laid. By means of the bonding drive section 69, a bonding processing is applied to the circuit substrate 68. On the other hand, to make only the atmosphere

near the top of the circuit substrate 68 locally into a cleaner air than the whole apparatus interior, a clean air is discharged from the blowoff nozzle 70 and most of the discharged air is sucked and collected into the suction nozzle 71. The collected air is exhausted outside the apparatus. And, the atmosphere of the bonding processing space 66 is rectified through the rectification plates 72a, 72b and 73, passes through lead sections 74 and 75, joins together again, is made into a clean air and is circulated by the filter 63. By dint of a clean air curtain formed by the flow between the blowoff nozzle 70 and the suction nozzle 71, the local atmosphere above the circuit substrate 68 is kept to a higher level of cleanliness than the apparatus interior. In addition, use of this curtain prior to the bonding processing permits the removing operation of dust adhered to the surface of a circuit substrate 68.

FIG. 21 shows a change with time of the dust concentration in individual atmosphere at the start of operation of the above bonding apparatus. The typical grain size of dust particles to be measured is $0.5\ \mu\text{m}$ or greater and is expressed by the number of particles in the volume of one-foot cubic. The spaces to be measured are chosen for a general environment work place (● mark) in which a bonding apparatus is provided as manufacturing apparatus, the center of the processing space 66 in the apparatus shown in FIG. 20 (○ mark with right-rising hatching: referred to as in-apparatus primary screen space) and the top vicinity of the

circuit substrate 68 (o mark: referred to as in-apparatus secondary space). The atmosphere above the circuit substrate 68 enveloped with an air curtain proves to enter the clearest state at the early stage.

Alternatively, FIG. 22 shows comparison of the result of the top vicinity (@ mark: the same in-apparatus secondary screen space) observed when an overheated steam at 350°C is mixed into the clean gas discharged from the blowoff nozzle 70 and the resultant mixture is fed under conditions of the same flow rate and that of a case where the clean gas discharged is fed without mixing (o mark: the same in-apparatus secondary screen space). It is revealed that the mixing of overheated steam into the clean air increases a time change in decreasing dust concentration and finally improving the lowest attainable concentration.

FIG. 23 shows comparison of the time change in decreasing dust concentration of the top vicinity of the circuit substrate 68 between the center of the clean-room interior in the atmosphere of a general environment and the bonding-apparatus interior. The dimension of the clean room compared in this experiment is 20 m in width x 10 m in depth x 5 m in height. It follows from FIG. 23 that it took about 2 hours till the clean-room interior reaches to a possible state of bonding processing (below 100 grains/ft³), whereas the bonding processing of a circuit substrate became possible in about one minute from the operation start of the cleaning mechanism in a bonding apparatus according to an embodiment of the present invention.

CLAIMS:

1. A manufacturing apparatus requiring a clear atmosphere for the processing of workpieces such as parts or products, comprising:
 - 5 a cabinet for dividing the apparatus interior and a general environment;
at least one of circulating means for circulating the atmosphere inside said cabinet through a filter or feed means for feeding a clean gas into said cabinet;
detection means for detecting the level of cleanliness of the apparatus interior, and
control means for controlling at least either one of said circulation means or said
10 feed means in accordance with data on the level of cleanliness detected by said detection means to maintain the level of cleanliness of the in-apparatus space.
2. A manufacturing apparatus as set forth in claim 1, further comprising:
 - 15 means for forming a clean gas in a line or curtain around said workpiece and forming a processing space having a locally higher level of cleanliness than that of the external environment.
3. A manufacturing apparatus as set forth in claim 1 or 2, further comprising:
 - 20 mix means for mixing the vapor, mist, droplets or gas of a substance functioning to remove dust or unnecessary component matters into a clean gas.
4. A manufacturing apparatus requiring a clear atmosphere for the processing of workpieces such as parts or products, comprising:
 - 25 an enclosure for dividing said workpiece and a general environment;
means for forming a clean gas in a line or curtain on the open surface of said enclosure and forming a clear local processing space enabling said workpiece to be processed; and
mix means for mixing the vapor, mist, droplets or gas of a substance functioning to remove dust or unnecessary component matters into a clean gas.

- 40 -

5. A manufacturing apparatus requiring a clear atmosphere for the processing of workpieces such as parts or products, comprising:
- a cabinet for dividing the apparatus interior and a general environment; and
 - at least one of circulating means for circulating the atmosphere inside said cabinet
- 5 through a filter or feed means for feeding a clean gas into said cabinet,
- wherein a carrying-in preparatory chamber for removing unnecessary component matters adhered to said workpiece with said clean gas is additionally provided outside the said cabinet; and
- 10 mix means for mixing the vapor, mist, droplets or gas of a substance functioning to remove dust or unnecessary component matters into a clean gas is provided.