

DEVICE FOR CLEANING THE INTERIOR OF A PIPE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to devices for cleaning the interior of a pipe member of piping, a scrubber or the like and, more specifically, to a device for preventing constituents of a fluid, such as dust, flowing through such a pipe member from adhering to the inner wall of the pipe member, or blowing off or washing away such an adhering matter.

Description of the Related Art

As shown in Figs. 7 and 8, various processing gases used in a semiconductor fabricating process are supplied to a CVD apparatus 27 where they cause various chemical reactions to perform different treatments, such as deposition, dry etching and cleaning, required in semiconductor wafer processing. Thereafter, such gases are discharged as exhaust gas from the CVD apparatus 27. Such processing gases include SiH_4 , SiH_2Cl_2 and like gases, which are mostly harmful to humans and explosive.

Exhaust gas 31 discharged from the CVD apparatus 27 after the necessary processing has been completed contains unreacted residues of the processing gases supplied to the CVD apparatus 27, harmful and explosive reaction products newly produced in the CVD apparatus 27, dust, and other constituents.

Conventionally, such exhaust gas 31 discharged from the CVD apparatus 27 is first diluted with a large quantity of nitrogen gas to a concentration lower than the lower explosion limit, then diluted with air to a concentration lower than a regulatory value, and finally emitted as it is into the atmosphere.

Such emission of exhaust gas into the atmosphere has recently been strictly regulated from the viewpoint of environmental protection against the greenhouse effect and pollution of the atmosphere, soil and water. For this reason, some semiconductor fabricating plants have recently been equipped with a harm removing device 29. To such a harm removing device 29 are fed harmful and explosive exhaust gas 31, dust 30 and other exhaust fluids which have been used in the CVD apparatus 27 or produced by chemical reactions caused in other apparatus through piping 22. Dust 30 contained in exhaust gas 31 is likely to adhere to the inner wall of the piping and gradually deposit thereon, thereby narrowing the inner diameter of the piping.

Periodical maintenance is required to remove dust 30 deposited on the inner wall of piping 22. Generally, such maintenance is conducted in such a manner that an inspection hole 23 is opened in a portion of piping 22 and a brush is inserted into the piping 22 through the inspection hole 23 to brush deposited dust 30 off and collect the same. Prior to such

maintenance, residual harmful and explosive exhaust gas 31 in the piping 22 is purged by charging the piping 22 with a sufficient amount of nitrogen gas. However, some portion of such harmful and explosive gas still remains in the deposited dust 30 despite such purge and is possible to cause explosion due to reaction with oxygen contained in air flowing into the piping 22 upon opening of the inspection hole 23. Therefore, the maintenance needs to be effected frequently for dust 30 not to accumulate excessively.

During the maintenance the operation of CVD apparatus 27 must be stopped. Accordingly, frequent maintenance lowers the availability of the equipment, hence, lowers the productivity. It is, therefore, critical to inhibit deposition of dust 30 on the inner wall of piping 22 to the largest possible extent and minimize the number of times of maintenance of piping 22 in ensuring sufficient safety and productivity.

A scrubber 32 of the harm removing device 29 suffers from a similar problem. Specifically, the scrubber 32 has a top portion into which an exhaust gas introducing pipe 33 connected to the piping 22 is inserted. The periphery of the exhaust gas introducing pipe 33 is formed with a water supply section 34 for supplying water to wash away dust 30 adhering to the inner periphery of the scrubber 35. Deposition of dust 30 on the inner periphery of the scrubber 35 itself can thus be prevented. However, high-temperature exhaust gas 31 is rapidly cooled upon

contact with inner periphery 33a of the water-cooled exhaust gas introducing pipe 33 and, hence, the water content contained in exhaust gas 31 and peripheral gas mixed with exhaust gas 31 condense on the inner periphery 33a. Dew adhering to the inner periphery 33a, which results from such condensation, captures dust 30 contained in exhaust gas 31 to form a gradually growing dust layer, which finally clogs the exhaust gas introducing pipe 33. In this way, dust 30 contained in exhaust gas 31 forms a deposition layer on any portion within the piping extending from the outlet of the CVD apparatus 27 to the outlet of the exhaust gas introducing pipe 33 of the scrubber 32, thereby causing the piping to be clogged.

Accordingly, it is an object of the present invention to provide a device for cleaning the interior of a pipe member of, for example, piping or a scrubber, which is capable of preventing any constituent of a fluid, such as dust, discharged from production equipment from adhering to the inner wall of the pipe member, or blowing off or washing away an adhering matter on the inner wall.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a device for cleaning the interior of a pipe, comprising: a tubular main body having a slit section defining a slit obliquely extending through a peripheral wall of the tubular main body

from an outer wall surface thereof toward an inner wall surface thereof in a flowing direction of a fluid flowing through the tubular main body; an outer tubular portion enclosing the slit section; and a fluid jetting portion located within a fluid sump space defined between the outer tubular portion and the tubular main body, the fluid jetting portion having a fluid jet nozzle oriented circumferentially of the tubular main body.

According to this construction, a protective fluid jetted from the fluid jetting portion into the fluid sump space flows toward the slit section at a high velocity while spirally whirling around the tubular main body. The protective fluid is then jetted into the tubular main body through the slit and flows into a pipe member of, for example, general piping or a scrubber. In the pipe member the protective fluid flows in the flowing direction of an exhaust fluid while spirally whirling along the inner wall of the pipe member due to its centrifugal force. Since the protective fluid advances while contacting the inner wall surface of the pipe member in that manner, a spirally whirling fluid layer is formed on the inner wall of the pipe member.

The spirally whirling fluid layer thus formed on the inner wall serves to protect an inner wall surface of the tubular main body extending from the slit portion and the inner wall of the succeeding pipe member of general piping, scrubber or the like. Accordingly, the exhaust fluid flowing in the pipe member is prevented from contacting the inner wall of the pipe member and,

hence, adherence of dust contained in the exhaust fluid to the inner wall can be inhibited. It is, therefore, possible to reduce the number of times of such maintenance that the interior of the pipe member is brushed through an inspection hole not shown, or in an extreme case, dust deposited on or adhering to the inner wall of the pipe member is removed by dismantling the general piping or the scrubber.

In a preferred embodiment of the present invention, the tubular main body is configured to be connectable to general piping. Alternatively, the tubular main body is configured to be connectable to an exhaust gas inlet of a scrubber.

With such a feature, the cleaning device of the present invention, which is constructed separately from any piping or any scrubber, can be connected to general piping at any appropriate halfway point thereof or to an exhaust gas inlet located in a top portion of any scrubber. Accordingly, it is possible to determine the number of such cleaning devices to be connected to general piping as desired, or to newly connect or additionally connect the cleaning device to any existing piping or scrubber.

Another preferred embodiment of the present invention further comprises a heater disposed within the fluid sump space.

The protective fluid to be jetted from the fluid jetting portion is compressed. The temperature of the protective fluid lowers due to adiabatic expansion when the fluid is jetted into

the fluid sump space. The cleaning device having the heater disposed within in the fluid sump space is capable of heating the protective fluid of which the temperature has lowered. If an exhaust fluid containing some corrosive component in a gaseous state condenses into dew due to a decrease in its temperature, such dew corrodes general piping for example. Heating of the protective fluid with the heater makes it possible to prevent such condensation thereby effectively protecting the pipe member of general piping or a scrubber.

In yet another preferred embodiment of the present invention, the fluid sump space is tapered toward the slit section.

Since the fluid sump space is tapered toward the slit section in this embodiment, the protective fluid jetted from the fluid jetting portion flows toward the slit section as increasingly compressed. As a result, the protective fluid is jetted through the slit into the tubular main body at a higher pressure thereby reliably forming the fluid layer on the inner wall of the tubular main body.

In still another preferred embodiment of the present invention, the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

The spirally extending partition wall restricts the flow of the protective fluid jetted from the fluid jetting portion between

adjacent threads thereof. Thus, the protective fluid is prevented from remaining within the fluid sump space until it reaches the slit section. As a result, a smooth spiral flow of the protective fluid can be formed.

The foregoing and other objects, features and attendant advantages of the present invention will be fully appreciated from the reading of the following detailed description taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front elevational view illustrating a cleaning device of the present invention in a state connected to general piping;

Fig. 2 is a sectional view of the cleaning device in a state connected to an exhaust gas inlet of a scrubber;

Fig. 3 is a longitudinal sectional view illustrating a first embodiment of the present invention;

Fig. 4 is a longitudinal sectional view illustrating a second embodiment of the present invention;

Fig. 5 is a longitudinal sectional view illustrating a third embodiment of the present invention;

Fig. 6 is a cross sectional view illustrating the cleaning device of the present invention;

Fig. 7 is a front elevational view showing a conventional piping state; and

Fig. 8 is a sectional view showing a conventional scrubber.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described in detail by way of embodiments with reference to the attached drawings.

Fig. 1 illustrates part of semiconductor fabricating equipment, including a CVD apparatus 17, an exhaust fan 18 for exhausting an exhaust fluid 20 from the CVD apparatus 17, general piping 2, a cleaning device 1 of the present invention, and a harm removing device 19 for removing harmful components from the exhaust fluid 20. Fig. 2 illustrates an example of a scrubber 24 forming part of the harm removing device 19.

The cleaning device 1 of the present invention is described below by way of embodiments. As shown in Fig. 3, a cleaning device 1A as a first embodiment of the present invention comprises a tubular main body 4 allowing the exhaust fluid 20 to flow therethrough, an outer tubular portion 3 extending around of the tubular main body, a fluid jetting portion 5 located in a fluid sump space 7 defined between the tubular main body 4 and the outer tubular portion 3, and a heater 9 disposed in the fluid sump space 7.

The internal diameter of the tubular main body 4 is equal to that of the general piping 2 or an exhaust gas inlet 25 of the scrubber 24 and, hence, the tubular main body 4 can be connected integral with the general piping 2 or the scrubber 24 with their

bores coinciding with each other. The tubular main body 4 has a slit section defining a slit over the entire circumference of the tubular main body 4, the slit obliquely extending through the peripheral wall of the tubular main body 4 from an outer wall surface thereof toward an inner wall surface thereof in the flowing direction of the exhaust fluid 20. The more acute the angle α of the obliquely extending slit with respect to the tubular main body 4, the more preferable for the reason to be stated later. The leading and trailing edges of the tubular main body 4, which are on the downstream side and on the upstream side, respectively, are provided with flanges 16 and 15, respectively. The flanges 16 and 15 are adapted to be coupled with flanges 15a and 16a, respectively, of the general piping 2 or with flanges 26 of a pipe member connected to the exhaust gas inlet 25 of the scrubber 24.

On the outer periphery of the main tubular body 4 is located the outer tubular portion 3 so as to enclose the slit section 6. The fluid sump space 7 is defined between the tubular main body 4 and the outer tubular portion 3. The trailing edge of the outer tubular portion 3 is secured to the trailing edge of the main tubular body 4, while the leading edge of the outer tubular portion 3 lies at a location just beyond the slit section. The slit section 6 provides communication between the fluid sump space 7 and the inside space of the tubular main body 4.

A portion 12 receiving the fluid jetting portion 5 (hereinafter referred to as "jet nozzle receiving portion 12") is located on the outer tubular portion 3 adjacent the slit section 6, and a heater cord receiving portion 14 is located upstream of the jet nozzle receiving portion 12. The locations of the heater cord receiving portion 14 and the jet nozzle receiving portion 12, however, may be reversed relative to each other.

The fluid jetting portion 5, which is inserted into the fluid sump space 7 from the jet nozzle receiving portion 12 located adjacent the slit section 6, is bent at its tip portion to orient a fluid jet nozzle 5a circumferentially of the tubular main body 4. The cleaning device according to this embodiment has two fluid jetting portions 5 at locations opposite to each other on the circumference of the main tubular body 4. However, the number of fluid jetting portions 5 to be provided is not limited, and the provision of a larger number of fluid jetting portions allows a higher-pressure flow of the protective fluid 10 to be formed. Two heater cords 13 are inserted through the heater cord receiving portion 14 and connected to the heater 9 disposed in the fluid sump space 7.

Though this embodiment uses an inert gas such as nitrogen gas as the protective fluid 10 to be jetted, any gas may be used unless it reacts with the exhaust fluid 20. The cleaning device 1 of the subject embodiment is applicable to any other piping than that of CVD apparatus 17. Further, the cleaning

device 1 may use some liquids such as water.

In the embodiment the general piping 2 is provided with cleaning devices 1A at intervals of 3 to 4 m. The distance between adjacent cleaning devices 1A may be increased if the protective fluid 10 is of a greater mass such as cleaning water or the jetting pressure of the protective fluid 10 becomes higher. Examples of usable protective fluids 10 include gases such as inert gases, for example, nitrogen gas and argon gas, and liquids such as water and various chemical liquids, for example, alkaline or acidic liquids. In the subject embodiment nitrogen gas is used.

The cleaning device according to the subject embodiment operates as follows. The protective fluid 10 is jetted from the fluid jetting portion 5 projecting into the fluid sump space 7. The protective fluid 10 jetted through a fluid jet nozzle 5a whirls within the fluid sump space 7 around the main tubular body 4 and spirally flows toward the slit section 6 defining the slit which is the sole opening in the fluid sump space 7.

The protective fluid 10 is compressed before being jetted from the fluid jetting portion 5 but expands upon injection into the fluid sump space 7. Though the temperature of the protective fluid 10 lowers temporarily due to expansion of the fluid 10, the protective fluid 10 is heated by the heater 9 so as to be maintained at a desired temperature. Accordingly, the temperature of the exhaust fluid 20 will not lower when the

exhaust fluid 20 contacted by the protective fluid 10. For this reason, a corrosive component in a gaseous state, which may be contained in the exhaust gas 20, will not condense within a pipe member K of the general piping 2 or the scrubber 24.

In a similar manner, the protective fluid 10 introduced into the tubular main body 4 through the slit spirally advances while contacting an inner wall surface of the tubular main body 4 extending downstream of the slit section 6 and flows into the general piping 2 or the scrubber 24.

In this way the protective fluid 10 spirally jetted into the tubular main body 4 through the slit section 6 forms a fluid layer 11 on the inner wall of the tubular main body 4 and on the inner wall of the pipe member K of the general piping 2 or the scrubber 24. As the protective fluid 10 flows a longer distance from the slit section 6, the flow strength of the protective fluid 10 is lessened due to contact resistance caused between the fluid 10 and the inner walls. In the case of the general piping 2 provided with the cleaning devices 1A, however, the cleaning devices 1A are connected to the piping 2 at such intervals as not to cause the flowing strength to be lessened too much, for example, 3 to 4 m and hence the fluid layer 11 is repeatedly renewed to avoid breaking-off of the fluid layer 11.

When the inner wall of the pipe member K of the piping 2 or scrubber 24 is confirmed as being protected by the fluid layer 11, the exhaust gas 20 produced within the CVD apparatus 17 is

fed to the harm removing device 19 by means of an exhaust fan 18. The exhaust fluid 20 introduced into the general piping 2 from the CVD apparatus 17 by means of the exhaust fan 18 does not directly contact the inner wall of the general piping 2 because the fluid layer 11 is formed on the inner wall. The exhaust fluid 20, therefore, reaches the scrubber 24 without adhering to the inner wall of the piping 2. Since the scrubber 24 is also provided with cleaning device 1 at its exhaust gas inlet 25, the inner wall of the scrubber 24 is protected by a spiral flow of protective fluid 10 jetted into the scrubber 24 from the cleaning device 1. Thus, deposition of dust within the scrubber 24 is unlikely.

The protective fluid 10 may be jetted either continuously or intermittently while the exhaust gas is being discharged. In the former case the exhaust fluid 20 is wholly embraced by the protective fluid 10 from the beginning to end of its passage, while in the latter case the flow of the protective fluid 10 blows off dust when dust have accumulated to some extent. In Fig. 1, reference numeral 21 designates a valve adapted to pass or stop the protective fluid 10.

A second embodiment 1B is described below. For convenience of illustration, description is focused on the features that are different from the first embodiment 1A. As shown in Fig. 4, cleaning device 1B according to this embodiment includes a tubular main body 4, an outer tubular portion 3, and a

fluid jetting portion 5.

As in the first embodiment 1A, the outer tubular portion 3 extends so as to enclose a slit section 6 defining a slit extending through the peripheral wall of the tubular main body 4. Unlike the outer tubular portion in the first embodiment, the outer tubular portion 3 in this embodiment is shaped such that a liquid sump space 7 defined thereby is tapered toward the slit section 6. Though the fluid jetting portion 5 projects into the fluid sump space 7 as in the first embodiment 1A, the fluid jetting portion 5 is located upstream of the location of the first embodiment fluid jetting portion in the fluid sump space 7.

The second embodiment 1B operates as follows. As in the first embodiment 1A, the protective fluid 10 jetted into the fluid sump space 7 from the fluid jetting portion 5 whirls around the tubular main body 4. Since the fluid jetting portion 5 is located on the upstream side of the fluid sump space 7, the protective fluid 10 spirally flows toward the slit section 6 located on the downstream side.

At this time, the protective fluid 10 becomes compressed as it comes closer to the slit section 6 because the fluid sump space 7 is tapered toward the slit section 6, and reaches the slit section 6 while spirally whirling. Thus, the flow velocity of the protective fluid 10 increases as the fluid 10 comes closer to the slit section 6 and, hence, the pressure of the protective fluid 10 to be jetted into the tubular main body 4 through the slit

increases. The operation thereafter is the same as in the first embodiment.

A third embodiment 1C is described below. For convenience of illustration, description is focused on the features that are different from the second embodiment 1B. As shown in Fig. 5, cleaning device 1C according to this embodiment defines a fluid sump space 7 tapered toward a slit section 6 as in the second embodiment and has a partition wall 8 spirally extending from a jet nozzle receiving portion 12 to the slit section 6 within the fluid sump space 7.

The third embodiment 1C operates as follows. Protective fluid 10 jetted into the fluid sump space 7 from the fluid jetting portion 5 whirls around the tubular main body 4. Since the spirally extending partition wall 8 is provided in the fluid sump space 7, the protective fluid 10 thus jetted flows along the partition wall 8 between adjacent threads thereof and is gradually compressed as it comes closer to the slit section 6 while increasing its flow velocity. The protective fluid 10 jetted into the tubular main body 4 at a high velocity forms a spiral protective fluid layer 11 on an inner wall surface of the tubular main body 4 extending downstream of the slit section 6 and on the inner wall of the pipe member of the general piping 2 or scrubber 24. The operation thereafter is the same as in the foregoing embodiments.

As has been described above, the cleaning device of the

present invention is capable of forming a spirally whirling fluid layer on an inner wall surface of the main tubular body extending downstream of the tubular main body and on the inner wall of a pipe member of general piping or a scrubber connected to the cleaning device. By continuously jetting the protective fluid into the cleaning device, it is possible to prevent an exhaust fluid flowing through the pipe member from directly contacting the inner wall thereof thereby to inhibit adherence or deposition of any constituent of the exhaust fluid. Alternatively, by intermittently jetting the protective fluid into the cleaning device, it is possible to blow off or wash away dust adhering to the inner wall of the pipe member. Thus, the cleaning device of the present invention makes it possible to largely prolong the maintenance cycle.

While only presently preferred embodiments of the present invention have been described in detail, as will be apparent for those skilled in the art, certain changes and modifications may be made in embodiment without departing from the spirit and scope of the present invention as defined in the following claims.



What is claimed is:

1. A device for cleaning the interior of a pipe, comprising: a tubular main body having a slit section defining a slit obliquely extending through a peripheral wall of the tubular main body from an outer wall surface thereof toward an inner wall surface thereof in a flowing direction of a fluid flowing through the tubular main body; an outer tubular portion enclosing the slit section; and a fluid jetting portion located within a fluid sump space defined between the outer tubular portion and the tubular main body, the fluid jetting portion having a fluid jet nozzle oriented circumferentially of the tubular main body.

2. The device according to claim 1, wherein the tubular main body is configured to be connectable to general piping.

3. The device according to claim 1, wherein the tubular main body is configured to be connectable to an exhaust gas inlet of a scrubber.

4. The device according to claim 1, further comprising a heater disposed within the fluid sump space.

5. The device according to claim 2, further comprising a heater disposed within the fluid sump space.

6. The device according to claim 3, further comprising a



heater disposed within the fluid sump space.

7. The device according to claim 1, wherein the fluid sump space is tapered toward the slit section.

8. The device according to claim 2, wherein the fluid sump space is tapered toward the slit section.

9. The device according to claim 3, wherein the fluid sump space is tapered toward the slit section.

10. The device according to claim 4, wherein the fluid sump space is tapered toward the slit section.

11. The device according to claim 5, wherein the fluid sump space is tapered toward the slit section.

12. The device according to claim 6, wherein the fluid sump space is tapered toward the slit section.

13. The device according to claim 1, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

14. The device according to claim 2, wherein the fluid sump



space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

15. The device according to claim 3, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

16. The device according to claim 4, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

17. The device according to claim 5, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

18. The device according to claim 6, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

19. The device according to claim 7, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

20. The device according to claim 8, wherein the fluid sump space is provided with a partition wall spirally extending from a



portion receiving the fluid jetting portion to the slit section.

21. The device according to claim 9, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

22. The device according to claim 10, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

23. The device according to claim 11, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.

24. The device according to claim 12, wherein the fluid sump space is provided with a partition wall spirally extending from a portion receiving the fluid jetting portion to the slit section.