

SPECIFICATION

Vertical Thermal Processing Apparatus

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TECHNICAL FIELD

The present invention relates to a vertical thermal processing apparatus.

BACKGROUND TECHNOLOGY

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As one of the thermal processing apparatuses for a process of every kind of heat treatment applied to an object-to-be-processed, e.g. a semiconductor wafer, such as oxidation, diffusion, CVD and annealing for example, a vertical thermal processing apparatus has been used for its ability in

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simultaneously heat-treating a large quantity of wafers.

In this vertical thermal processing apparatus, a processing container is provided for accommodating and applying heat treatment to a plurality of wafers, and a tubular heater is installed covering the circumference of the processing container. A conventional heater comprises heater elements provided at the internal circumference of a tubular heat-insulating material.

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However, the aforementioned vertical thermal processing apparatus has a problem that, in case of deterioration or breakdown of the heater element, such as disconnection, the entire heater needs to be replaced instead of solely replacing the heater element because the heater element and the heat-insulating material are formed in one piece. On the other hand, a heater providing a plurality of individually replaceable heater elements is proposed. However, the structure of a vertical thermal processing apparatus generally allows maintenance to be performed through one specific side of a chassis that houses a heater, and the problem is that workability i.e. maintainability is quite low when performing maintenance such as replacement or repair of heater element located on the other side (opposite side) inside the chassis.

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DISCLOSURE OF THE INVENTION

The present invention is presented in consideration of the above circumstances and is intended to provide a vertical thermal processing apparatus that can facilitate maintenance work such as replacement of a heater element, thus achieving high maintainability.

In order to accomplish the above purpose, the vertical thermal processing apparatus according to the present invention is characterized by comprising: a processing container for accommodating and applying heat treatment to a large quantity of objects-to-be-processed; a tubular heater covering the circumference of said processing container; a heater installation part for installing said heater; and a chassis for housing said heater wherein maintenance of said heater can be performed through one of the sides of said chassis, said heater having a plurality of heater elements that are individually replaceable, said heater installation part comprising rotary support mechanisms for supporting the heater rotatably.

According to the present invention, when maintenance work such as replacement of the heater element located on the other side inside the vertical thermal processing apparatus is performed, the heater is rotated to make a part-to-be-maintained face one specific side inside the chassis to easily perform the maintenance work, thus achieving high maintainability.

The vertical thermal processing apparatus of the present invention can have securing members for securing the rotation of the heater which is supported rotatably by said rotary support mechanisms. According to the present invention, the securing members can secure the heater so as not to be rotated at a certain angle.

The vertical thermal processing apparatus of the present invention can be structured in that each of said rotary support mechanisms has a lifting member for lifting said heater up and down and a support member for supporting said heater rotatably. According to the present invention, the heater can

be moved upwardly and downwardly by the lifting members and supported by the support members. In this manner, the heater can be lifted up and supported rotatably and lifted down with its rotation secured.

5 The vertical thermal processing apparatus of the present invention can be structured in that each of said rotary support mechanisms is a threaded lifting member or a fluid-pressure actuated lifting member and said support member is any one of low-frictional members including a sphere, a roller
10 and a Teflon. According to the present invention, the heavy weight heater can be lifted up and rotated easily by a simple structure, thus achieving high maintainability.

 The vertical thermal processing apparatus of the present invention is preferably structured in that said support
15 members are all positioned on the same circumference and an annular guiding groove which is engaged with said support members is provided in the bottom portion of said heater. According to the present invention, the heater can assuredly and easily be rotated along the circumference, thus achieving
20 high maintainability.

 The vertical thermal processing apparatus of the present invention is characterized by comprising:
a processing container for accommodating and applying heat treatment to a large quantity of objects-to-be-processed;

25 a tubular heater covering the circumference of said processing container; a heater installation part for installing said heater; and a chassis for housing said heater wherein maintenance of said heater can be performed through one specific side of said chassis, said heater having a plurality of
30 heater elements that are individually replaceable, said heater installation part comprising rotary support mechanisms for supporting the heater rotatably, wherein said heater is equipped with a plurality of the heater elements at the internal circumference of a tubular cover body with a water-cooling
35 structure and a terminal portion of each of said heater elements is protruded from the external circumference piercing through

said cover body to be connected to a connector. According to the present invention, by combining the factors that the terminal portions of the heater elements protrude from the external circumference piercing through the cover body and the
5 heater is provided with the rotary support mechanism, maintenance such as replacement of the heater element is facilitated, thus achieving high maintainability.

The vertical thermal processing apparatus of the present invention is preferably structured in that
10 connector-support members is provided on the external circumferential surface of said cover body of said heater and said connector-support member secures said connectors thereto. The vertical thermal processing apparatus of the present invention can be structured in that connector-support member
15 is provided on the external circumferential surface of said cover body of said heater and said connector-support member secures said connectors and fixing brackets of said terminal portions of said heater elements thereto.

According to the present invention, the connectors, or
20 the connectors and the fixing brackets, are secured to the connector-support member, thus facilitating detachment/attachment of the terminal portions of the heater elements.

The vertical thermal processing apparatus of the present invention is characterized in that annular
25 connector-support member which is substantially horizontally protruded in a radially outward direction from said heater is provided on the external circumferential surface of said cover body of said heater and said connector-support member secures
30 said connectors and/or fixing brackets of said terminal portions of said heater elements thereto. According to the present invention, because the connector-support member substantially horizontally protrudes from the external circumferential surface of the cover body of the heater in a radially outward direction
35 with respect to the heater, detachment/attachment work of the secured connectors or the secured fixing brackets of the

terminal portions of the heater elements can be facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal sectional view of a vertical thermal processing apparatus showing an embodiment of the present invention.

Fig. 2 is a diagrammatic sectional view showing the structure of a rotary support mechanism.

Fig. 3 is an enlarged sectional view of the structure of a jack member.

Fig. 4 is a bottom plan view of a jack member.

Fig. 5 is an enlarged sectional view showing the structure in that a rotary support mechanism rotatably supports a heater and a fixing member fixes the heater.

Fig. 6 is a diagrammatic sectional view showing the structure of a rotary support mechanism having a roller as a support member.

Fig. 7 is a diagrammatic sectional view showing the structure of a rotary support mechanism having a Teflon as a support member.

BEST EMBODIMENTS FOR REALIZING THE INVENTION

With reference to the accompanying drawings, an embodiment of the present invention will be explained below in detail. Fig. 1 is a longitudinal sectional view of a vertical thermal processing apparatus showing an embodiment of the present invention, Fig. 2 is a diagrammatic sectional view showing the structure of a rotary support mechanism (rotary support assembly), Fig. 3 is an enlarged sectional view of the structure of a jack member and Fig. 4 is a bottom plan view of a jack member. In Fig. 2, the left half shows a heater fixed and the right half shows a heater jacked up.

In Fig. 1, 1 is a vertical thermal processing apparatus having a chassis 11 forming an outer framework of the vertical thermal processing apparatus 1, and a vertical heat-treating furnace 2 is provided in the upper area inside the chassis 11 to

accommodate objects-to-be-processed, e.g. semiconductor wafers, for performing predetermined treatment, e.g. oxidation treatment. This heat-treating furnace 2 mainly consists of: a vertically long processing container e.g. a reaction tube 4 made
5 of silicon dioxide which has an opening at the bottom end as a furnace opening 3; a cover member 5 which opens and closes the furnace opening 3 of the reaction tube 4 and is vertically movable; and a heater 6 which is provided to cover the circumference of the reaction tube 4 and can control heating of
10 the reaction tube (furnace) 4 inside up to a predetermined temperature, 300 to 1,200°C for example.

In the chassis 11, a base plate (heater installation part) 7, made of stainless steel for example, for installing the reaction tube 4 and the heater 6 thereon which constitute the
15 heat-treating furnace 2 is horizontally provided by way of a cradle 29 as shown in Fig. 2. In the base plate 7, an opening 7a is formed for upwardly inserting the reaction tube 4 from below. The heater 6 is so housed as to enable maintenance to be carried out through one specific side of the chassis 11. For
20 performing maintenance of the heater 6, a maintenance opening 11a is formed in one of the sides of the chassis 11 and is normally closed with a cover, not shown.

The reaction tube 4 is made of silicon dioxide for example, and is in the form of a single tube in the shown
25 example (embodiment). At the lower-end portion of the reaction tube 4, an outward flange portion 4a is formed. A flange-holding member 8 holds the flange portion 4a in the lower part of the base plate 7, thereby holding the reaction tube 4 to stay upwardly inserted from below through the opening 7a
30 of the base plate 7. The reaction tube 4 can be detached downwardly from the base plate 7 for cleaning, etc.

At the flange portion 4a of the reaction tube 4, a plurality of gas inlet pipes 9 are provided for inducing process gas and purging inert gas into the reaction tube 4, and gas
35 supply plumbing is connected to these gas inlet pipes 9. Additionally, the diameter of the top portion of the reaction tube

4 is progressively reduced, an vent 10 is formed in this top portion in an L shape, and discharge plumbing with vacuum pumps, pressure control valves, etc. that can control depressurization inside the reaction tube 4 is connected to this vent 10 (drawing omitted).

Below the base plate 7 in the chassis 11, a loading area 12 is provided for loading/unloading a heat-treatment boat 16 provided on the cover member 5 into/from the heat-treating furnace 2 (i.e. the reaction tube 4) or transferring wafers to the boat 16. In this loading area 12, a lift mechanism 13 is provided for moving the cover member 5 vertically to load/unload the boat 16.

The cover member 5 is made of stainless steel for example and held on a holding plate 15 linked by plurality buffer mechanisms, springs 14 for example, and this holding plate 15 is joined to the lift mechanism 13. The cover member 5 is so structured as to seal the furnace opening 3 by directly contacting with the open end thereof. At the bottom center of the cover member 5, a rotation mechanism 20 is provided for rotating the boat 16.

The boat 16 is made of silicon dioxide for example and comprises: a boat body 17 for horizontally supporting a large quantity of wafers W, e.g. approximately 75 to 100, with large diameter, e.g. 300 mm, leaving gaps between each other in a vertical direction in multiple columns; and a leg portion 18, as one-legged, joined to a rotating shaft of the rotation mechanism 20 that rotates this boat body 17 along the circumference of the wafers. These boat body 17 and leg portion 18 are formed in one piece. A flange portion 19 is formed on the leg portion 18 and fixed to the rotating shaft portion of the rotation mechanism 20 by a screw.

On the cover member 5, a furnace-opening heating mechanism 21, as furnace-opening insulating means, is secured. This furnace-opening heating mechanism 21 mainly consists of: an annular cover plate 22 so mounted to cover the upper surface of the cover member 5; a plurality of struts 23 built up

on this cover plate 22 in a circumferential direction leaving proper gaps between each other; a planer resistance heating element 24 provided horizontally lying over the upper-end portions of these struts 23; and a plurality e.g. a pair of heat shield plates 25 provided with a proper gap therebetween under this resistance heating element 24 lying over the struts 23.

The cover plate 22, struts 23 and heat shield plates 25 are made of silicon dioxide for example, and the upper surface of the cover member 5 is protected by the cover plate 22 from corrosive processing gas. Through the resistance heating element 24 and the heat shield plates 25, through-holes 26 are provided in which the leg portion 18 including the flange portion 19 of the boat 16 pierces through. On the holding plate 15, a conducting pipe 27 is so provided as to airtightly pierce through the cover member 5 for conducting a cable that supplies electricity to the resistance heating element 24. On the cover plate 22, annular heat shield covers 28, doubled in the shown example, are provided which cover the circumference and upper side of the flange portion 19. These heat shield covers 28 are made of silicon dioxide for example and formed by two halves for easy attachment/detachment.

As for the heater 6, it mainly consists of: a tubular preferably cylindrical cover body 30 having water-cooling structure; and a plurality of heater elements 31 provided at the internal circumference of this cover body 30 allowing individual replacement. The cover body 30 has an annular bottom plate portion 30a at its lower-end portion and an annular top plate portion 30b at its upper-end portion in one piece. The vent 10 of the reaction tube 4 protrudes from an opening 32 of this top plate portion 30b. The cover body 30 is preferably made of stainless steel for example. In the cover body 30, a water-flow path 33 is provided, for example helically, to circulate cooling water.

The heater elements 31 is constituted by a carbon heater and has terminal portions 34 at both ends thereof, the carbon heater being formed by weaving for example carbon

fiber bundles as a resistance heating element into a vertically long shape and then enclosing the woven carbon fiber bundles inside a silicon tube. As the heater elements 31, a main heater element 31a provided along a vertical line of the internal circumference of the cover body 30, an upper heater element 31b provided in the upper part of the internal circumference of the cover body 30, a lower heater element 31c provided in the lower part of the internal circumference of the cover body 30 and a top heater element 31d provided at the opening 32 of the top plate portion 30b are used. The upper heater element 31b is formed in a tortuous manner and the lower heater element 31c and the top heater element 31d are formed in a helical manner.

Each of the heater elements 31 is disposed at the internal circumference of the cover body 30, and the terminal portion 34 of each of the heater elements 31 is protruded from the external circumference piercing radially through the cover body 30 and is connected to a connector 35. Annular collar-like members 36 (support members for the connectors) are provided on the upper and lower sections of the external circumference of the cover body 30, and to each of these collar-like members 36, a connector 35 connected to the terminal portion 34 and a fixing bracket 37 for supporting and securing the intermediate part of the terminal portion 34 are attached. The connector 35 is electrically connected to an electric power supply by way of a cable 38.

In the base plate 7 as a heater installation part, a rotary support mechanism 40 (a rotary support assembly) is provided for rotatably supporting the heater 6 for rotating the heater 6, thereby moving the part-to-be-maintained to face one specific side (the side of the maintenance opening 11a) inside the chassis 11 for easier maintenance work, in a case that maintenance work such as replacing the heater element 31 is performed at the opposite side of the maintenance opening 11a inside the chassis 11. This rotary support mechanism 40 comprises: a plurality e.g. 4 of threaded jack members 41 for

lifting the bottom portion of the heater 6 (the lower surface of the bottom plate portion 30a) up and down; and a sphere 42 (a supporting member) provided in the upper part of each of the jack members 41 rotatably for supporting the bottom portion of the heater 6 rotatably.

As shown in Fig. 3 or Fig. 4, the jack member 41 mainly consists of: a threaded-rod portion (lifting member) 43 having an engaging portion 43a which is hexagonal for example and the lower-end portion of which is engaged with a rotary tool; a bracket portion 44 into which this threaded-rod portion 43 is vertically movably screwed; and the sphere 42 (a supporting member) provided rotatably in the upper-end portion of the threaded-rod portion 43 by way of a sphere-supporting portion (bearing) 45. The bracket portion 44 is attached to the lower surface of the base plate 7 with a plurality e.g. 3 of screws 46 in an attachable/detachable manner. The jack member 41 can be referred to as a rotary support mechanism based on a ball-point-pen mechanism because the sphere 42 is provided rotatably to the end portion of the threaded-rod portion 43.

In the base plate 7, a hole 47 is provided for the tubular upper-end portion of the bracket portion 44 to be engaged therewith and vertical movement of the sphere-supporting portion 45 including the sphere 42 to be allowed therethrough. The sphere-supporting portion 45 is provided onto the end portion (upper-end portion) of the threaded-rod portion 43, and the sphere 42 is housed and supported rotatably inside the sphere-supporting portion 45 with a part of the sphere 42 protruding from the upper-end portion of the sphere-supporting portion 45. In the bracket portion 44, a housing recess 48 is formed for housing the sphere-supporting portion 45 including the sphere 42 in a manner that the sphere 42 does not protrude over the upper surface of the base plate 7. Although the jack members 41 may be permanently attached, they can be attached for use only when maintenance of the heater 6 is carried out.

The jack members 41 are preferably made of stainless steel for example. Furthermore, a flange portion 44a is formed around the external circumference of the upper-end portion of the bracket portion 44. This flange portion 44a is securely
5 fixed to the lower surface of the base plate 7 with the screws 46. In this configuration, holes 19 through which head portions 46a of the screws 46 can be inserted respectively are provided in the flange portion 44a corresponding to the location of the screws 46 screwed in the base plate 7, and elongated holes 49a
10 through which the head portions 46a of the screws 46 cannot be inserted respectively while allowing the circumferential relative movement of the screws 46 in these holes 49 (i.e. circular movement of the bracket portion 44) are provided, in order to detach the jack members 41 without unscrewing the screws 46.

15 To accomplish the stable circumferential (around the axial center) rotation or rotatable support of the heater 6, the jack members 41 (spheres 42 as support members, to be precise) are positioned on a circumference whose center is the axial center of the heater 6 (i.e. on a concentric circle with the
20 heater 6), and an annular guiding groove 50 is provided in the bottom portion of the heater 6 for the spheres 42 of the jack members 41 to be engaged therewith. This guiding groove 50 is formed annularly on a concentric circle with the heater 6. Preferably, the guiding groove 50 is a groove with a V-shaped
25 section.

The heater 6 is secured onto the base plate 7 with setscrews 51 screwed thereinto from below, normally. When maintenance of the heater 6 is performed, it only requires to unscrew the setscrews 51 and jack up the heater 6 to a
30 predetermined height h from the upper surface of the base plate 7 by rotating the threaded-rod portions 43 of the jack members 41 with a rotary tool. In this way, the heater 6 can be easily rotated. Note that 39 in Fig. 1 is an annular heat-insulating material having a two-half structure provided on the upper
35 portion of the heater 6 in order to cover the opening 32 between the vent 10 and the heater 6.

When performing maintenance such as replacement of the heater elements 31, the reaction tube 4 is detached from the base plate 7, removed downwardly from inside the heater 6 and resited. The workability is quite poor when replacing the heater element 31 on the left side in Fig. 1 for example, i.e. on the opposed side of the maintenance opening 11a of the chassis 11, since it is difficult to reach the rear of the heater 6.

Given such situation, the setbolt 51 securing the heater 6 to the base plate 7 is unscrewed and the heater 6 is jacked up (lifted up) by the jack member 41 that constitutes the rotary support mechanism 40 of the heater 6. In this case, the threaded-rod portion 43 is rotated by engaging a rotary tool such as a spanner with the engaging portion 43a at the lower end of the threaded-rod portion 43 that constitutes the jack member 41 so that the threaded-rod portion 43 can be moved upwardly by a lead screw mechanism. As a result, the sphere at the upper end of the jack member is engaged with the guiding groove 50 in the bottom portion of the heater 6 and pushes up the bottom portion of the heater 6, thereby easily lifting the heavy weight heater 6 up from the upper surface of the base plate 7.

After horizontally lifting up the heater 6 by handling all the jack members 41, the heater 6 is rotated by hand so as to make the heater element 31 on the left side in Fig. 1 face the maintenance opening 11a on the right side. Because the spheres 42 are provided to the upper portion of the respective jack members 41, the heater 6 can be rotated smoothly and easily. When the heater element 31 to be replaced is turned to the right side in Fig. 1, the terminal portion 34 of the heater element 31 to be replaced is removed from the fixing bracket 37 and connector 35 of the collar-like portion 36, and then the heater element 31 to be replaced is detached from inside the heater 6, i.e. the inner side of the cover body 30, to be replaced by a new heater element. In this way, maintenance such as replacement of a heater element can be easily performed.

According to the vertical thermal processing apparatus

1 with the above-mentioned structure which comprises: the reaction tube 4 as a processing container for accommodating and applying heat treatment to a large quantity of wafers W; the tubular heater 6 covering the circumference of the reaction tube 4; the base plate (heater installation part) 7 for installing the reaction tube 4; and the chassis 11 for housing the heater 6 in which maintenance can be performed through one specific side of the chassis, said heater 6 having a plurality of heater elements 31 that are individually replaceable, said base plate 7 comprising the rotary support mechanism 40 for supporting the heater 6 rotatably, can achieve high maintainability by rotating the heater 6 to make a part-to-be-maintained face one specific side inside the chassis 11 to easily perform the maintenance work when maintenance work such as replacement of the heater element 31 located on the other side inside the chassis 11 is performed.

The heater 6 in this structure is equipped with a plurality of the heater elements 31 at the internal circumference of the tubular cover body 30 with a water-cooling structure, and the terminal portion 34 of each of the heater elements 31 is protruded from the external circumference piercing through the cover body 30 to be connected to the connector 35. As shown in Fig. 1, the heater element 31 can easily be detached from the internal circumference of the cover body 30 by removing the terminal portion 34 from the connector 35 at the outer side of the cover body 30, because the collar-like member 36 is substantially horizontally extended from the outer circumferential surface of the cover body 30 in a radially outward direction with respect to the heater 6, and the connectors 35 and the fixing brackets 37 of the heater elements are aligned in a orderly fashion on the surface of this collar-like member 36. By combining the ease of detachment in this way and the heater 6 providing the rotary support mechanism 40, maintenance such as replacement of the heater element 31 is facilitated, thus achieving high maintainability.

In addition, since the rotary support mechanism 40

comprises: a plurality of threaded jack members 41 for lifting the bottom portion of the heater 6 up and down; and the sphere 42 provided rotatably in the upper part of each of the jack members 41 for supporting the bottom portion of the heater 6 rotatably, the heavy weight heater 6, e.g. approximately 340kg, can be lifted up and rotated easily by a simple structure, thus achieving high maintainability. Moreover, since the jack members 41 are positioned on the same circumference and the annular guiding groove 50 which is engaged with the spheres 42 of the jack members 41 is provided in the bottom portion of the heater 6, the heater 6 can assuredly and easily be rotated along the circumference, thus achieving high maintainability.

Another embodiment of the present invention will be hereinafter explained.

In the embodiment in Figs. 1 to 4, the rotary support mechanism 40 can lift the bottom portion of the heater 6 up and down, the heater 6 is secured as shown in the left half of Fig. 2 by moving the threaded-rod portions 43 downwardly during normal operation, and the threaded-rod portions 43 are moved upwardly for the heater 6 to be rotatable for performing maintenance such as replacement of the heater element 31.

On the contrary, the rotary support mechanism can have a non-liftable structure in which the heater 6 is constantly supported while the rotation of the heater 6 can be secured during operation and necessary maintenance, in the present invention. Fig. 5 shows an example of a securing member for securing the rotation of the heater 6.

In Fig. 5, a plurality of holes are provided through the bottom plate portion 30a of the cover body 30 and through the base plate 7 interfaceable with each other, and bolts 60 as securing members pierce through the bottom plate portion 30a of the cover body 30 and the base plate 7 in a configuration that the corresponding holes are interfaced with each other. Note that although the structure of the rotary support mechanism 40 allows the spheres 42 to move vertically in Fig. 5, the rotary support mechanism 40 also can have a structure

allowing no vertical move of the support member while the heater 6 is supported rotatably. Additionally, although the bolt 60 is pierced thorough the holes provided through the bottom plate portion 30a of the cover body 30 and the base plate 7 using the bolt 60 as a securing member in Fig. 5, any other
5 securing members are feasible according to those skilled in the art. For example, a wedge member may be driven between the bottom plate portion 30a of the cover body 30 and the base plate 7.

10 In the embodiment in Figs. 1 to 4, the support member supporting the bottom portion of the heater 6 is the sphere 42.

Those skilled in the art can have alternative means for the support members as long as the heater 6 can be supported rotatably. For example, the support member can be a roller 61
15 as shown in Fig. 6. In this case, a guiding groove 62 preferably is provided in the bottom surface of the bottom plate portion 30a of the cover body 30 in order to guide the roller 61. Furthermore, the support member can be a low-frictional member 63 as shown in Fig. 7. As the low-frictional member, a
20 Teflon 63 can be used. Preferably a support body holds the circumference of the Teflon 63 whose top surface preferably having direct contact with the bottom surface of the bottom plate portion 30a of the cover body 30. In this case as well, a guiding grove 64 preferably is provided in the bottom surface of
25 the bottom plate portion 30a for guiding the Teflon 63.

In each of the embodiments above, the support member (sphere 42, roller 61 or Teflon 63) to support the heater rotatably is provided in the upper part of the lifting member (threaded-rod portion 43) integrally to lift the heater
30 up and down. However, the support member (sphere 42, roller 61 or Teflon 63) and the lifting member (threaded-rod portion 43) can be separated. In this case, the support member can support the heater 6 rotatably and the lifting member can lift the heater 6 up and down.

35 Furthermore, although the jack member 41 is a threaded jack member comprising the threaded-rod portion 43

and bracket portion 44 in each of the embodiments above, a lifting member may be lifted up and down by a fluid-pressure actuated mechanism, such as oil pressure.

Although a connector-support member to support the
5 connector 37 is the collar-like member 36 in the embodiment in Figs. 1 to 4, the connector-support member can be in any alternative forms, for example a plate in any form protruded from the external circumferential surface of the cover body of the heater 6 in a radially outward direction with respect to the
10 heater.

While the embodiments of the present invention have been hereinabove explained in detail, the present invention is not intended to limit the invention to those embodiments but various changes and modifications such as a design change can
15 be made to the invention without departing from the spirit and scope of the invention. For example, the thermal processing apparatus may be structured to perform a CVD processing, diffusion treatment, annealing, etc. in addition to an oxidation treatment. The material of the boat may be silicon carbide,
20 polysilicon (Si), etc. for example instead of silicon dioxide. The object-to-be-processed can be an LCD substrate, silicon dioxide, etc. for example instead of a semiconductor wafer. In addition, the reaction tube can have a double-tube structure with an inner tube and an outer tube. The furnace-opening insulating
25 means can be an insulating tube.

WHAT IS CLAIMED IS:

1. A vertical thermal processing apparatus characterized by comprising:
a processing container for accommodating and applying heat treatment to a large quantity of objects-to-be-processed;
a tubular heater covering the circumference of said processing container;
a heater installation part for installing said heater; and
a chassis for housing said heater wherein maintenance of said heater can be performed through one specific side of said chassis,
said heater having a plurality of heater elements that are individually replaceable, said heater installation part comprising rotary support mechanisms for supporting the heater rotatably.
2. A vertical thermal processing apparatus according to claim 1 characterized by having securing members for securing the rotation of the heater which is supported rotatably by said rotary support mechanisms.
3. A vertical thermal processing apparatus according to claim 1 characterized in that each of said rotary support mechanisms has a lifting member for lifting said heater up and down and a support member for supporting said heater rotatably.
4. A vertical thermal processing apparatus according to claim 3 characterized in that each of said rotary support mechanisms is a threaded lifting member or a fluid-pressure actuated lifting member and said support member is any one of low-frictional members including a sphere, a roller and a Teflon.
5. A vertical thermal processing apparatus according to claim 3 characterized in that said support members are all positioned on the same circumference and an annular guiding groove which is engaged with said support members is provided in the bottom

portion of said heater.

6. A vertical thermal processing apparatus characterized by comprising:

a processing container for accommodating and applying heat treatment to a large quantity of objects-to-be-processed;

a tubular heater covering the circumference of said processing container;

a heater installation part for installing said heater; and

a chassis for housing said heater wherein maintenance of said heater can be performed through one specific side of said chassis,

said heater having a plurality of heater elements that are individually replaceable, said heater installation part comprising rotary support mechanisms for supporting the heater rotatably, wherein said heater is equipped with a plurality of the heater elements at the internal circumference of a tubular cover body with a water-cooling structure and a terminal portion of each of said heater elements is protruded from the external circumference piercing through said cover body to be connected to a connector.

7. A vertical thermal processing apparatus according to claim 6 characterized in that connector-support member is provided on the external circumferential surface of said cover body of said heater and said connector-support member secures said connectors thereto.

8. A vertical thermal processing apparatus according to claim 6 characterized in that connector-support member is provided on the external circumferential surface of said cover body of said heater and said connector-support member secures said connectors and fixing brackets of said terminal portions of said heater elements thereto.

9. A vertical thermal processing apparatus according to claim 6

characterized in that annular connector-support member which is substantially horizontally protruded in a radially outward direction from said heater is provided on the external circumferential surface of said cover body of said heater and said connector-support member secures said connectors and/or fixing brackets of said terminal portions of said heater elements thereto.