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Hammond

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[54] **HEAT TREATING APPARATUS**

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[52] **U.S. Cl.** **214/26,** 432/253, 432/258

[51] **Int. Cl.** **F27b 9/00**

[58] **Field of Search** ..... 214/18 R, 23, 26; 432/253, 432/258, 239, 241

[56] **References Cited**

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3,294,261	12/1966	Cloutier	214/18 R
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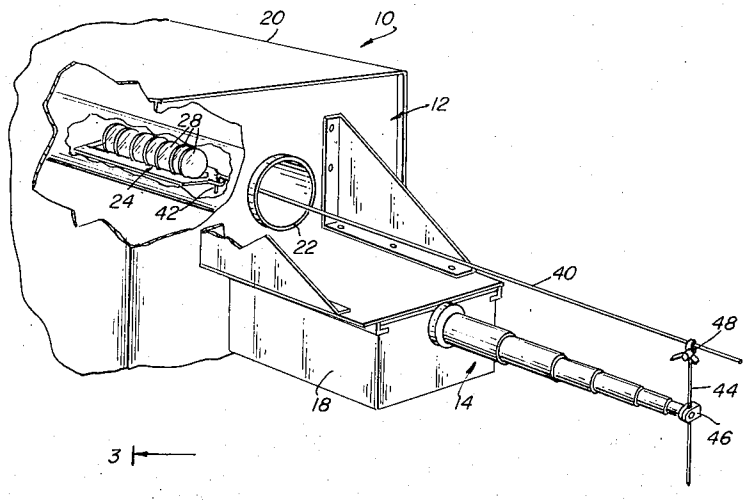
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[57] **ABSTRACT**

An apparatus is provided for heat treating semiconductor elements in a diffusion furnace in which an interface is formed between the apparatus and the interior heat treating chamber of the furnace.

9 Claims, 5 Drawing Figures



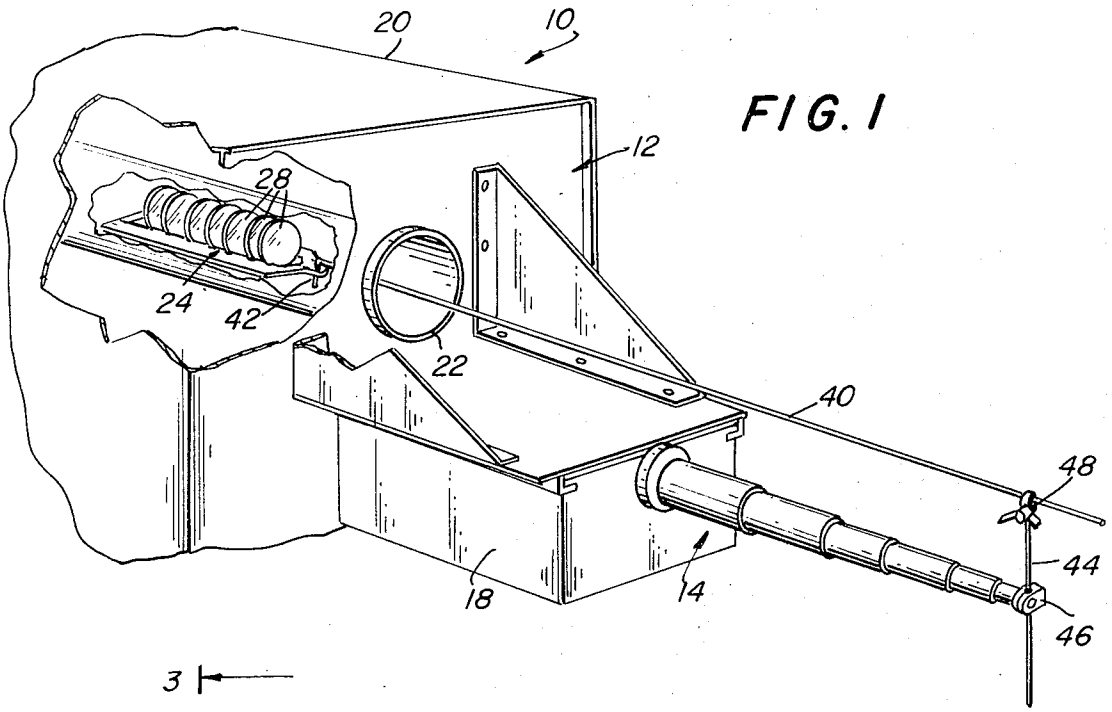


FIG. 1

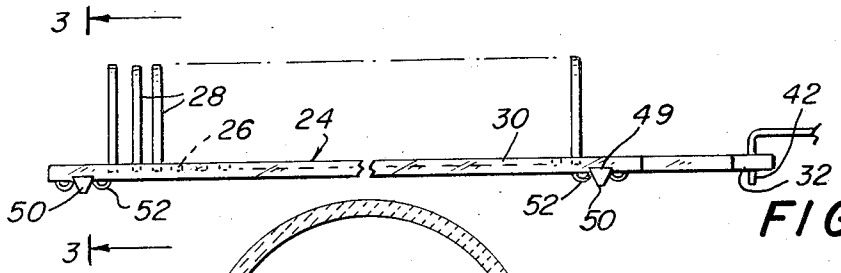


FIG. 2

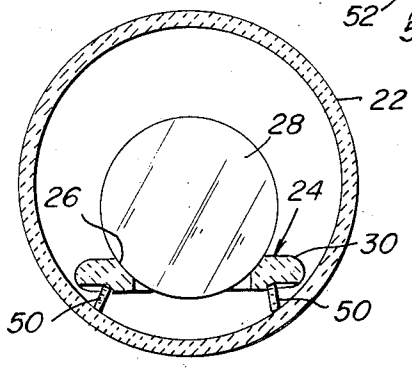


FIG. 3

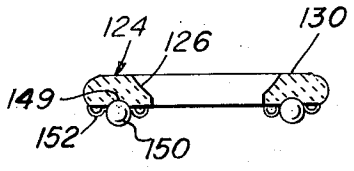


FIG. 4

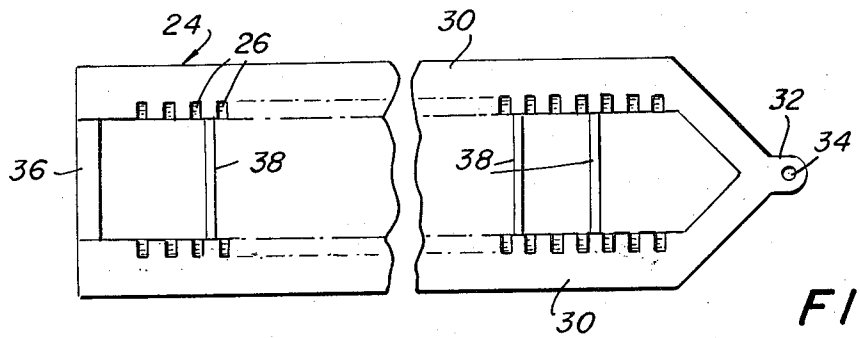


FIG. 5

HEAT TREATING APPARATUS

BACKGROUND OF THE INVENTION

In the heat treatment of semi-conductor materials, there is usually provided a furnace that is traversed by a movable fixture of quartz or glass on which, the semi-conductor elements are positioned. The usual type of glass or quartz fixture has a tendency to stick to the interior surface of the furnace, thereby making it impossible to move the fixture in the furnace. In this connection, it should be noted that heat treating furnaces are usually provided with mechanical devices which are capable of extending and retracting the fixture at a relatively slow rate such that a uniform heat treating procedure can be applied to the semi-conductor elements. Since the mechanical actuating device is automatically operated by an electric motor, the fixture has a tendency to stick to the surface and then become dislodged by the actuator device which often results in the semi-conductor elements being damaged by vibration or actually broken through being dislodged from the fixture. It has been found that the adherence of the fixture to the internal surface of the furnace results from the furnace being operated at a temperature which is very close to the fusion temperature of the quartz material from which the fixture is formed. Also, during some heat treating operations, there is a formation of a thin film of tacky substance formed along the internal surface of the furnace, thereby further causing the fixture to stick to the furnace walls. The adherence of the fixture to the furnace is prevented in accordance with the invention by providing an interface between the fixture and the furnace wall. This interface essentially provides point contact between the fixture and the furnace wall, thereby reducing the area subject to the fusion or sticking.

SUMMARY OF THE INVENTION

In accordance with an illustrative embodiment demonstrating features and advantages of the present invention, there is provided apparatus for heat treating semi-conductor elements in a diffusion furnace having an internal heat treating chamber. The apparatus comprises an elongated carrier formed with means for positioning the semi-conductor elements. Means are provided on the fixture for forming an interface between the fixture and the heat treating chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

The above brief description, as well as further objects, features, and advantages of the present invention will be more fully appreciated by reference to the following detailed description of presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in connection with the accompanying drawings wherein:

FIG. **1** is an elevational view of a heat treating furnace and linear actuator mechanism, with portions of the heat treating furnace being broken away to better illustrate the present invention;

FIG. **2** is an elevational view of an embodiment of the carrier in accordance with the present invention which is shown removed from the heat treating furnace;

FIG. **3** is a cross-sectional view of the carrier shown in FIG. **2**, positioned in the heat treating furnace tube;

FIG. **4** is a sectional view similar to FIG. **3**, but showing a sectional view of a carrier in accordance with a further embodiment of the present invention; and

FIG. **5** is a plan view of the carrier shown in FIG. **2**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. **1**, there is shown a heat treating apparatus generally designated by the reference numeral **10** which comprises a furnace **12** upon which there is mounted a linear actuator mechanism **14**. The linear actuator mechanism **14** includes a series of arms **16** which can be telescopically extended and retracted into a housing **18** in which there is mounted a gear driven motor. A more detailed description of the linear actuator can be obtained from applicant's U.S. Pat. No. 3,592,070 which has been granted on July 13, 1971. The furnace **12** comprises a housing **20**, in which there is mounted a heat treating cylindrical tube **22** which is usually fabricated from quartz or glass material.

Movably mounted in the tube **22** is a carrier fixture **24** which is formed with a series of slots **26** for positioning semi-conductor wafers **28**. The carrier fixture **24** is formed from a pair of outer beam members **30**, the front portions of which converge at a tab section **32** which is formed with a circular opening **34**. The rear portion of the beam members **30** are joined by an end beam **36**, and a series of brace beams **38** are joined between the outer beam sections **30** for providing greater structural stability to the carrier fixture **24**. The carrier fixture **24** is slideably connected to the linear actuator mechanism **14** by means of a pull rod **40**, one end of which is provided with a hook **42** for mounting in the opening **34**, and the other end of which is connected to a tie rod **44**. The outermost arm **16** of the linear actuator **14** is secured to tie rod **44** by means of a clamp **46** and the pull rod **40** is secured to tie rod **44** by means of a wing nut clamp **48**.

As best shown in FIG. **2**, the outer beams **30** of carrier fixture **24** are provided with slots **49** which are formed to receive wedge elements **50**. In order to secure the wedge elements **50** to the carrier fixture **24**, wedge elements **50** are positioned in the slots **49** and a pair of rods **52** are fused to the beam members **30** on either end of slot **49**. Since the wedge elements **50** are formed with a configuration generally conforming to the frustum of a triangle, the base of the wedge elements **52** are fixed in position within the slots **49** by means of the rods **52**. The rods **52** are fused to the carrier fixture **24** by applying heat to a pair of relatively straight quartz stock material such that the rods **52** are bent over and brought into contact with the opposite ends of the wedge unit **50** fused to ends of slot **49**. Depending on the specific application, it is also possible to secure the wedge elements **50** without the use of any of the rods **52**. This is accomplished by applying heat around the edges of slots **49**, such that the wedge elements **50** are surrounded by a perimeter of fused quartz. The wedge elements **50** are preferably fabricated from silicone carbide material which is compatible with diffusion processes, such that contamination will not be produced in the furnace **22** which would result in the semi-conductor wafers **28** being spoiled.

Turning to FIG. **4**, there is illustrated a further embodiment of the invention in which corresponding parts have been designated by the same reference numerals

as part of a "100" series. In this form of the invention, there is shown a carrier fixture **124** formed with semi-spherical indentations **148** which are provided for positioning spherical elements **150.** Each of the spherical elements **150** are positioned in the openings **148** by means of a pair of rods **152** in a manner similar to the mounting of the wedge elements **50** by means of the rods **52.** It is also possible to secure the spherical elements **150** by applying heat around the edges of apertures **148,** thereby eliminating the use of the rods **152.** As in the case of the wedge elements **50,** it is preferable to fabricate the spherical elements **150** from a material which is compatible with the diffusion processes such that contamination will not occur in cylindrical tube **22.**

It should be understood that the wedge elements **50** and spherical elements **150** have been designed to provide minimal contact between the elements (**50, 150**) and the inner surface of cylindrical tube **22,** such that point contact is essentially achieved. Thus, the elements (**50, 150**) could take a variety of equivalent shapes to obtain point contact. For example, the elevational view in FIG. **2** of the wedge elements **50** could be changed to a triangular shape or a semi-circular shape, and for the sake of simplicity these various shapes have not been shown in the drawings.

From the foregoing, it can be appreciated that in accordance with the present invention, there is provided carrier fixtures (**24, 124**) for heat treating semi-conductor elements **28** in the heat treating tube **22** of diffusion furnace **20.** The carrier fixtures (**24, 124**) are formed with slots (**26, 126**) for positioning the semi-conductor elements **28.** The wedge elements **50** and spherical elements **150** are respectively mounted on the carrier fixtures (**24, 124**) for forming an interface between carrier fixtures (**24, 124**) and the internal surface of heat treating tube **22.** Thus, by utilizing the wedge units **50** or the spherical units **150,** it is possible to essentially obtain point contact between the carrier fixtures (**24, 124**) and the internal surface of the furnace tube **22.**

A latitude of modification, change and substitution is intended in the foregoing disclosure and in some instances some features of the invention will be employed withou a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

What is claimed is:

1. Apparatus for heat treating semi-conductor elements in a diffusion furnace having an internal heat treating cylindrical chamber comprising an elongated carrier fixture formed with means for positioning said semi-conductor elements, a plurality of point contact support members mounted on said fixture, and each of said support members making point contact with the internal surface of said cylindrical chamber whereby an interface between said fixture and said heat treating chamber is established.

2. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **1** in which said means on said fixture comprise a plurality of wedge sections secured to the bottom of said fixture.

3. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **2** in which said wedge sections are fabricated from a material which is compatible with the operation within said diffusion furnace such that contamination will not occur within said diffusion furnace to adversely affect said semi-conductor elements.

4. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **2** in which said carrier fixture is fabricated from quartz material formed with a plurality of slot openings sized to receive said wedge sections.

5. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **2** in which said wedge sections are fabricated from silicone carbide material formed with a generally triangular shaped outer configuration.

6. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **1** in which said means on said fixture comprise a plurality of spherically shaped sections secured to the bottom of said fixture.

7. Apparatus for treating semi-conductor elements in a diffusion furnace having an internal heat treating chamber and a linear actuator capable of being extended and retracted within said chamber, comprising an elongated carrier fixture formed with means for positioning said semi-conductor elements, said carrier fixture mounted on said actuator for moving said fixture in said chamber, and a plurality of point contact support means on said fixture, and each of said support means making a point contact with the internal surface of said chamber, whereby an interface is established between said support means and said heat treating chamber, such that said support means are prevented from adhering to the surface of said heat treating chamber.

8. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **7** in which said means on said fixture comprise a plurality of wedge sections secured to the bottom of said fixture.

9. Apparatus for heat treating semi-conductor elements in a diffusion furnace according to claim **7** in which said carrier fixture is fabricated from quartz material formed with a plurality of slot openings sized to receive said wedge sections, such that said wedge sections can be secured to said fixture by applying heat to said slot openings.

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