United States Patent

Wells

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[54] SLICE CONVEYOR FURNACE

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[52] U.S. Cl. .....**263/6 R**, 198/213

[51] Int. Cl. **F27b 9/14**, F27d 3/00

[58] Field of Search 263/6, 7; 219/10.69; 214/21; 198/82, 213

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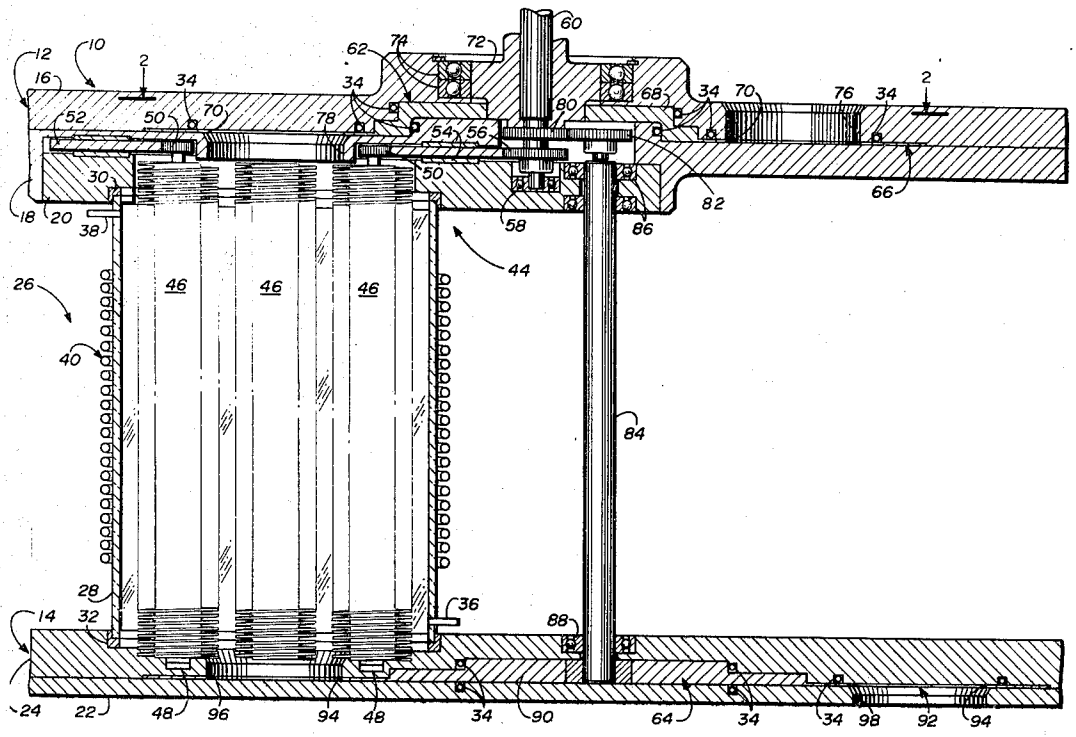
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[57] **ABSTRACT**

In a continuous flow asher furnace, an organic material removing environment is continuously maintained in a furnace chamber. Integrated circuit slices are continuously transported through the environment by lead screws positioned within the chamber. Disks mounted at opposite ends of the chamber are periodically indexed to rotate individual slices into and out of the furnace.

7 Claims, 2 Drawing Figures



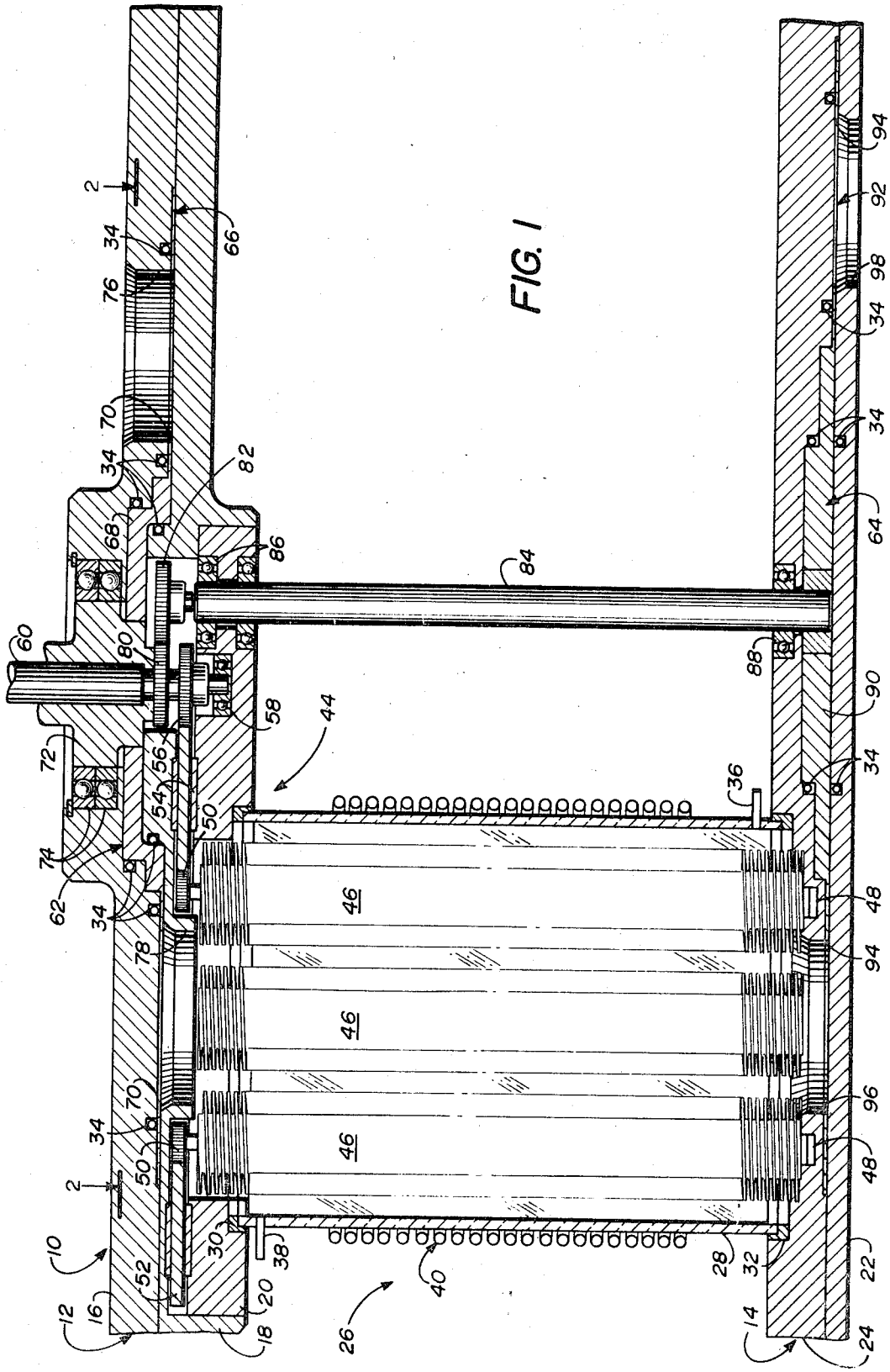

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FIG. 1

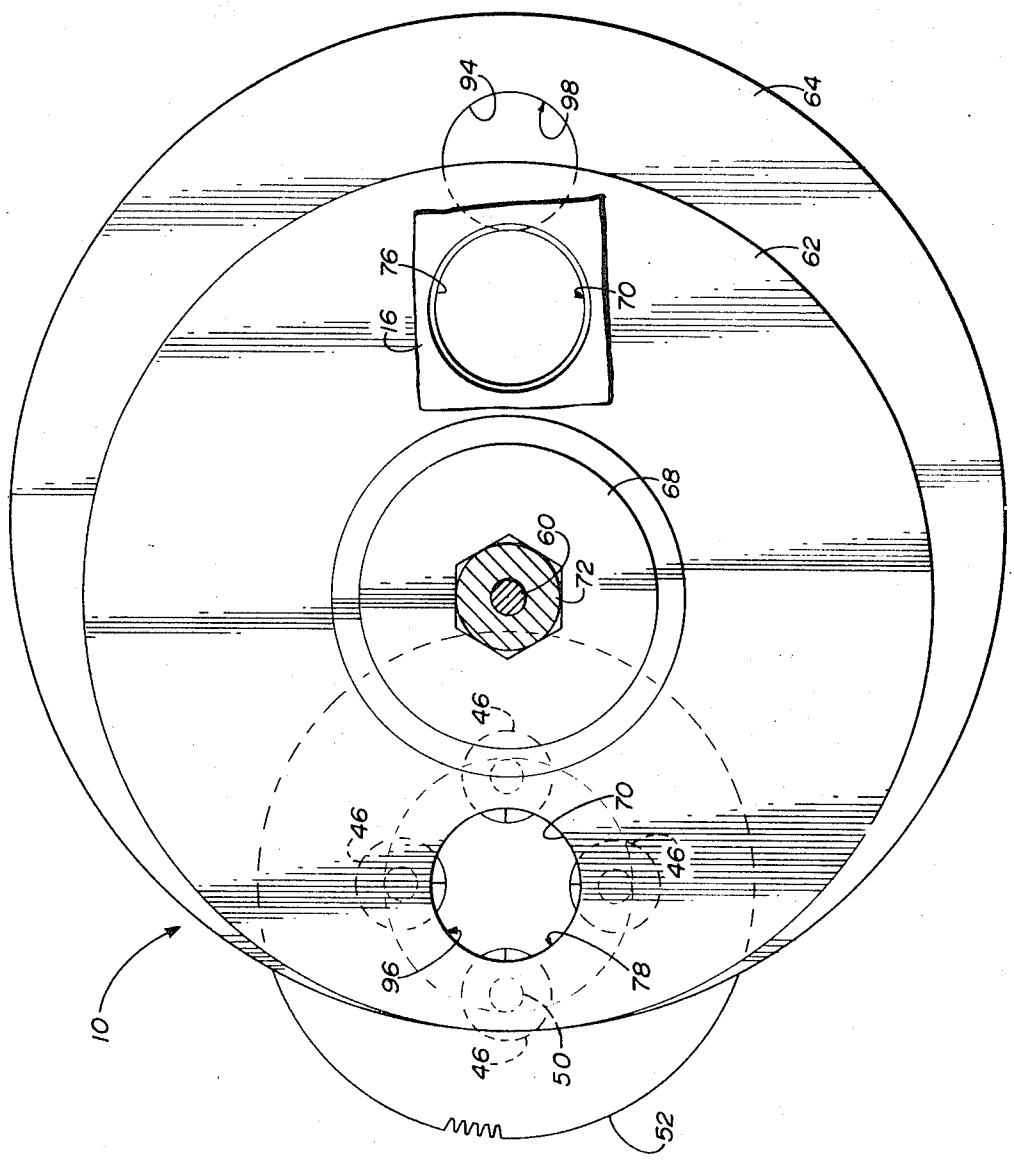


FIG. 2

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SLICE CONVEYOR FURNACE

During the fabrication of integrated circuit slices and similar products, various photoresist compounds, etching solutions and other organic materials are applied to the slices. Although these materials are frequently at least partially removed from the slices during subsequent operations, it is often desirable to remove all organic materials from the slices at the end of the slice forming process. Typically, this operation is performed in a device known as an asher furnace.

In an asher furnace, slices are heated in a controlled atmosphere that contains ionized oxygen. This procedure transforms all organic materials on the slices into carbon dioxide and water vapor. These gases are removed from the furnace so that at the end of the process, the slices are free of both organic materials and combustion byproducts.

In the past, most asher furnaces have been batch-process-type devices. Typically, a quantity of slices is loaded into a chamber and the chamber is sealed. The controlled atmosphere is then established in the chamber and the slices are heated. When all organic materials have been removed from the slices, the chamber is opened to permit removal of the treated slices and loading of a new batch of untreated slices.

Several problems result from the use of batch-type asher furnaces. For example, because it is difficult to maintain uniform temperature and atmospheric conditions throughout a furnace chamber, the slices comprising an individual batch are not all processed in the same manner. Also, because it is almost impossible to expose different batches of slices to the same temperature and atmosphere conditions, differences between slices processed in different batches are common.

This invention relates to a continuous flow asher furnace in which all slices are processed exactly alike. Each slice is transported through a chamber in which the temperature and atmosphere are continuously controlled. All slices are transported over the same path at the same rate. By this means, slice-to-slice and batch-to-batch variations between the slices are eliminated.

In accordance with the preferred embodiment, this invention comprises a continuous flow asher furnace in which an organic material removing environment is continuously maintained and in which workpieces are transported through the environment on an individual basis. Preferably, the environment is maintained in a sealed chamber and workpieces are transported through the environment by lead screws. Individual workpieces are rotated into and out of the furnace by disks mounted at opposite ends of the chamber.

A more complete understanding of the invention may be had by referring to the following detailed description when considered in conjunction with the drawings, wherein:

FIG. 1 is a sectional view of an asher furnace employing the invention, and

FIG. 2 is a top view of the device shown in FIG. 1 in which certain parts have been omitted more clearly to illustrate certain features of the invention.

Referring now to the drawings, and particularly to FIG. 1 thereof, a continuous flow asher furnace **10** employing the invention is shown. The furnace **10** includes a frame comprising an upper frame assembly **12** and a lower frame assembly **14**. The upper frame assembly **12** includes an outer plate **16**, an intermediate plate **18**, and an inner plate **20**. Similarly, the lower frame assembly **14** includes an outer plate **22** and an inner plate **24**. Suitable support members (not shown) extend between the assemblies **12** and **14**.

A furnace chamber **26** is positioned between the upper frame assembly **12** and the lower frame assembly **14**. The chamber **26** includes a quartz tube **28** which extends between the pair of sealing members **30** and **32** mounted in the plate **20** and the plate **24**, respectively. The ends of the chamber **26** are sealed by a plurality of sealing members **34** mounted in the several components of the frame assemblies **12** and **14**.

A pair of ports **36** and **38** extend into the upper end and lower end of the quartz tube **28**, respectively, for use in controlling the atmosphere within the chamber **26**. The interior of the chamber **26** is heated by an induction coil **40** positioned around the exterior of the tube **28**. The coil **40** is powered by a suitable source of induction heating power (not shown).

In the operation of the asher furnace **10**, an organic material removing environment is continuously maintained within the chamber **26** by continuously operating the induction coil **40**, by continuously directing a suitable atmosphere through the port **36** and by continuously removing combustion byproducts through the port **38**. Preferably, the environment in the chamber **26** includes ionized oxygen. Integrated circuit slices are continuously transported through the environment by a slice transporting mechanism **44**. The mechanism **44** operates to expose the slices to the organic material removing environment in the chamber **26** for a sufficient period of time to remove all organic materials from the slices.

The slice transporting mechanism **44** includes a plurality of lead screws **46** that are positioned in a circular array within the quartz tube **48**. Each lead screw **46** is supported in the plate **24** of the lower frame assembly **14** by a bearing **48**. Each lead screw **46** is driven through a spur gear **50** secured to its upper end.

The spur gears **50** are mounted in mesh with a ring gear **52**. The gear **52** is rotatably supported in the upper frame assembly **12** by a pair of ring-shaped polytetrafluoroethylene bearings **54** and is mounted in mesh with a spur gear **56**. The gear **56** is rotatably supported in the plate **20** by a bearing **58** and is secured to a shaft **60** which is in turn rotated by a suitable motor (not shown). The spur gear **56**, the ring gear **52**, and the spur gears **50** are so constructed that each lead screw **46** makes one complete revolution about its axis for each complete revolution of the shaft **60**.

The slice transporting mechanism **44** further includes an upper disk-shaped member **62** and a lower disk-shaped member **64** which moves slices into and out of the chamber **26**, respectively. The upper disk-shaped member **62** includes a hub portion **68** and a flange portion **66** having a thickness slightly greater than the thickness of the slices operated upon by the furnace **10**. The flange portion **66** has a pair of slice receiving apertures **70** formed in it. The hub portion **68** is secured to a drive hub **72** which is rotatably supported in the plate **16** of the upper frame assembly **12** by a pair of bearings **74**.

In use, the hub **72** is periodically rotated through half revolution increments by a suitable indexing mechanism, such as a Geneva or the like. Rotation of the hub **72** rotates the apertures **70** of the member **62** between a slice receiving hold **76** formed in the plate **16** and a hole **78** formed in the plate **18** of the frame assembly **12**. As the member **62** rotates, integrated circuit slices are moved in the apertures **70** between the hole **76** and the hole **78** as is best shown in FIG. **2**, the hole **78** is coaxial with the quartz tube **28** and a circle extending through the axis of all the lead screws **46**. Accordingly, slices transferred into alignment with the hole **78** by the member **62** immediately fall into engagement with the lead screws **46** for transportation thereby through the chamber **26**.

Referring again to FIG. **1**, the hub **72** is also secured to a spur gear **80**. The gear **80** is mounted in mesh with a gear **82** which has the same number of teeth as the gear **80**. The gear is secured to a shaft **84** which is rotatably supported in the plate **20** of the upper frame assembly **14** by a pair of bearings **86**. The shaft extends through the plate **24** of the lower frame assembly **16** and is rotatably supported therein by a bearing **88**.

The shaft **84** is mounted in driving engagement with the lower disk-shaped member **64**. The member **64** is similar to the member **62** in that it includes a hub portion **90** which is drivenly connected to the shaft **84** and an outer flange portion **92** having thickness slightly greater than the thickness of the slices operated upon by the furnace **10**. The member **64** includes a pair of slice receiving apertures **94** and operates to rotate the apertures **94** between a hole **96** formed in the plate **24** and a hole **98** formed in the plate **22** of the lower frame assembly **16**. As is shown in FIG. **2**, the hole **96** is coaxial with the center line of the tube **28** and the center of a circle extend-

ing through the axes of all lead screws **46**. Accordingly, slices which have been transported through the furnace **10** by the lead screws **46** fall through the hole **96** in the plate **26** into an aperture **94** in the member **64**. The member **64** rotates the slices in the apertures **94** into alignment with the hole **98** formed in the plate **24**, whereupon the slices fall from the furnace **10**.

The furnace **10** is intended for use as part of a continuous flow integrated circuit slice processing system. In such a system, slices are continuously deposited in the hole **76** by a slice delivery mechanism such as a track or the like. Preferably, the slice delivery mechanism deposits one slice in the hole **76** for each revolution of the shaft **60**. In such a case, the upper disk-shaped member **62** is indexed through a half revolution for each complete revolution of the lead screws **46** and operates to position a slice in engagement with each turn of the lead screws.

Similarly, slices discharged from the furnace **10** through the hole **98** are received by a slice removing mechanism such as an air track or the like. The slice removing mechanism is also coordinated with the operation of the furnace **10** so that slices are transported from the furnace to the next step in the slice processing system in timed sequence.

The asher furnace illustrated in the drawing differs from prior asher furnaces principally in that it is a continuous flow device. As opposed to batch-process-type furnaces, the environment in the chamber of the furnace according to the present invention is brought into a steady-state condition of temperature and atmosphere before the first slice is introduced into the chamber and is thereafter continuously maintained. The slice transporting mechanism of the furnace moves all slices along the same path and positions each slice within the furnace chamber for the same period of time. Thus, each slice is acted upon by the furnace in exactly the same manner. Because all slices are treated alike, the slice-to-slice and batch-to-batch variations that commonly occur in the batch processing operations are completely eliminated.

Another important advantage resulting from the use of the furnace illustrated in the drawings is that slices are operated upon by the furnace in sequence. That is, slices are discharged from the furnace in exactly the same order that they were introduced. This feature is very important in a continuous flow slice processing system because it permits exact control over the entire process. Furthermore, sequential operation permits both simplified tracing of the effects of engineering changes and more rapid correction of system failures.

Although only one embodiment of the invention is illustrated in the drawings and described herein, it will be understood that the invention is not limited to the embodiment disclosed but is capable of rearrangement, modification and

substitution of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. An asher furnace comprising:

a furnace chamber having workpiece admitting and discharging openings extending into it;

means mounted in the chamber for transporting workpieces between the openings, and;

means for moving workpieces into and out of alignment with the admitting and discharging openings, wherein the workpiece moving means includes a disk mounted at one end of the chamber for rotation between a slice receiving point and the admitting opening and a disk mounted at the other end of the chamber for rotation between a slice releasing point and the discharging opening.

2. The asher furnace according to claim **1** wherein the transporting means maintains the workpieces in sequence as they are transported through the environment.

3. The furnace according to claim **1** further including means for rotating the disks in synchronism so that one workpiece is discharged from the chamber for each workpiece admitted thereto.

4. The furnace according to claim **1** wherein said furnace chamber includes means for maintaining a preselected environment within said chamber.

5. In a furnace, a slice handling system comprising

a. a plurality of lead screws positioned at space points around an axis; and

b. means for delivering individual slices to a point on the axis at one end of the screws and for removing individual slices from a point on the axis at the other end of the screws wherein the delivery and removing means includes a pair of members having slice receiving openings formed in them and means for bringing the openings in the members into alignment with the points.

6. The furnace according to claim **5** wherein the delivery and removing means moves one workpiece out of engagement with the lead screws for each workpiece moved into engagement with the lead screws.

7. In a furnace, a slice handling system comprising:

a. a plurality of lead screws positioned at space points around an axis; and

b. means for delivering individual slices to a point on the axis at one end of the screws and for removing individual slices from a point on the axis at the other end of the screws wherein the delivery and removing means includes a pair of disk-shaped members having slice receiving apertures formed in them and means for rotatably supporting the disk-shaped members at opposite ends of the screws.

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